BRITISH COLUMBIA SEABIRD COLONY INVENTORY: REPORT #8: QUEEN CHARLOTTE STRAIT AND JOHNSTONE STRAIT

Michael S. Rodway
Moira J.F. Lemon

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ABSTRACT

The Canadian Wildlife Service conducted detailed inventories of seabird colonies in Queen Charlotte and Johnstone straits between 1982 and 1987 as part of the British Columbia Seabird Colony Inventory Program. Total or partial counts were made for surface-nesting species and small colonies of burrow nesters. Burrow densities on larger storm-petrel and alcid colonies were estimated using systematic sampling within quadrats surveyed along line transects. Due to time constraints, occupancy rates were not obtained on small storm-petrel (Oceanodroma sp.), Cassin's Auklet (Ptychoramphus aleuticus) and Rhinoceros Auklet (Cerorhinca monocerata) colonies, and population estimates were based on median occupancy rates at other colonies in the province.

The islands at the mouth of Queen Charlotte Strait are the most important breeding grounds for storm-petrels and Rhinoceros Auklets in British Columbia. They support 37% of the Fork-tailed Storm-Petrels (Oceanodroma furcata), 53% of the Leach's Storm-Petrels (O. leucorhoa), and 48% of the Rhinoceros Auklets nesting in the province (Rodway in press). Of the 28 extant colonies in the Queen Charlotte Strait region, the cluster of five colonies at the western entrance to the strait, including Storm Islands, Reid Islets, Tree Islets, Pine Island, and the Buckle Group, supports almost all (99.8%) of the over a million seabirds nesting in the region. By population, the region is second in importance only to the nearby Scott Islands. Breeding distribution and populations of Marbled Murrelets (Brachyramphus marmoratus), which likely nest in this region, are unknown.

RESUME

Dans le cadre de l'inventaire des oiseaux marins de la Colombie Britanique, le Service Canadien de la Faune a effectué entre 1982 et 1987 un inventaire détaillé des colonies d'oiseaux marins des détroits de la Reine Charlotte et de Johnston. Les espèces nichant en surface, de même que les petites colonies d'espèces nichant sous terre furent l'object d'un décompte complet ou partiel. Dans les grosses colonies de pétrels (Oceanodroma sp.) ou d'alcidés, les densités de terriers furent estimées à l'aide de quadrats placées de facon systématique le long de lignes de transects, elle mêmes établies de façon systématique. A cause de contraintes de temps, nous n'avons pas mesuré le taux d'occupation des terriers dans les petites colonies de pétrels, d'alques de Cassin (Ptychramphus aleuticus) et d'alques rhinocéros (Cerorhinca monocerata). Nous avons utilisées la mediane des taux d'occupation mésurées dans les autres colonies de la province pour dériver un estimé approximatif de la population de ces petites colonies.

Les îles situées à l'entrée du détroit de la Reine Charlotte contienment les colonies les plus importantes de pétrels et d'alques rhinocéros en Colombie Britanique. Elles supportent 37% des pétrels à queue fourchue (Oceanodroma furcata), 53% des pétrels cul-blanc (O. leucorhoa), et 48% des alques rhinocéros nichant dans la province. Parmi les 28 colonies situées dans le détroit de la Reine Charlotte, cinq colonies situées à l'entrée ouest de détroit (les îles tempêtes, les ilôts Reid et tree, l'île Pine et le groupe des îles Buckle) supportent 99.8% du million d'oiseaux marins nichant dans la région. En terme d'effectifs, cette region viens au second rang en importance aprés les les îles Scott. On ne connait pas la distribution et l'abondance de l'alque marbré (Brachyramphus marmoratus) qui niche probablement dans la région.

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The Seabird Colony Inventory was conducted and Permanent Monitoring Plots were established in Queen Charlotte and Johnstone straits as part of the Migratory Birds Conservation Program, Pacific and Yukon Region, Canadian Wildlife Service, supervised by G.W. Kaiser. Special technical advice has been received from G.E.J. Smith, J-P.L. Savard, and A.J. Gaston.

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INTRODUCTION

The islands at the mouth of Queen Charlotte Strait (Fig. QS-1) are the most important breeding grounds for storm-petrels (Oceanodroma sp.) and Rhinoceros Auklets (Cerorhinca monocerata) in British Columbia. They support 37% of the Fork-tailed Storm-Petrels (Oceanodroma furcata), 53% of the Leach's Storm-Petrels (O. leucorhoa), and 48% of the Rhinoceros Auklets nesting in the province (Rodway in press). Of the 28 extant colonies in the Queen Charlotte Strait region, the cluster of five colonies at the western entrance to the strait, including Storm Islands, Reid Islets, Tree Islets, Pine Island, and the Buckle Group, supports almost all (99.8%) of the over a million seabirds nesting in the region (Table QS-1). These islands were designated the Duke of Edinburgh Ecological Reserve in 1988. By population, the region is second in importance only to the nearby Scott Islands. Most of the birds nesting in the region could be endangered by local environmental contamination in proximity to those concentrations.

Surveys by the British Columbia Provincial Museum (now Royal B.C. Museum) in 1975 and 1976 (Campbell 1976; Campbell and Rodway 1977; BCNRS) identified most colony locations in the region, made total counts of surface nesting species, and made cursory population estimates of burrow nesting species. Except for surface nesting species, those estimates could not be used to determine changes or monitor trends. During 1982, 1984, 1985, 1986 and 1987, the Canadian Wildlife Service completed detailed inventories of seabird breeding colonies in Queen Charlotte and Johnstone straits. All other bird and mammal species sighted around colonies and other islands explored have been listed with each island account.

Breeding distribution and populations of Marbled Murrelets (Brachyramphus marmoratus), which likely nest in this region, are unknown. Special survey methodology will be required to address the unique conservations problems presented by this species (Sealy and Carter 1984; Rodway 1990).

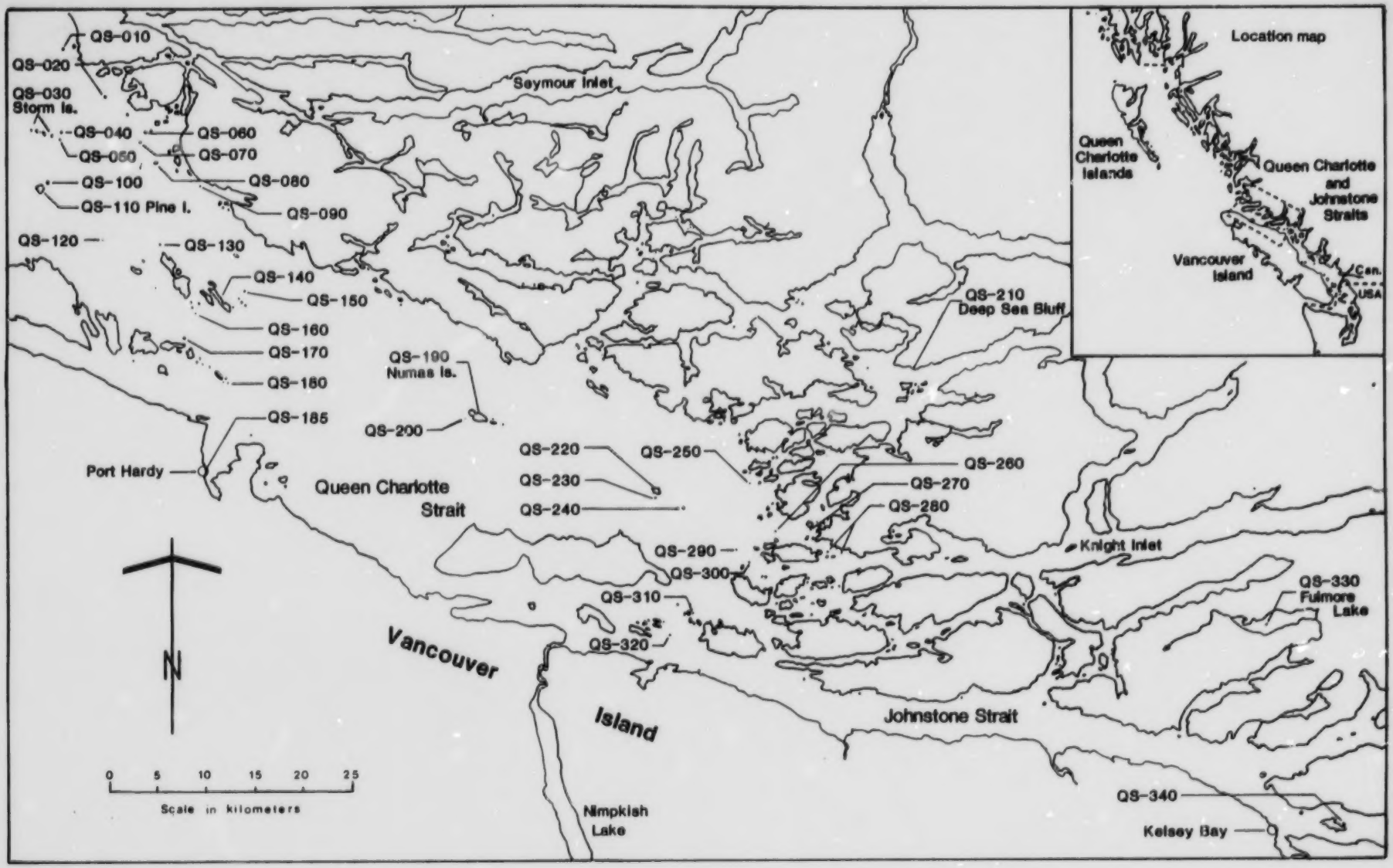

Figure QS-1. Seabird colonies in Queen Charlotte Strait and Johnstone Strait.

METHODS

Census methods were selected according to the area, habitat, and species of birds nesting on an island (Nettleship 1976). All islands were first explored to determine if nesting occurred. Small islands were completely examined. On large islands the entire perimeter was explored to a distance of 50 m from shore, plus frequent sections of the interior up to 200 m from shore. If no nesting seabirds were found no further searching was undertaken. If nesting was encountered exploration was continued to determine colony boundaries and the appropriate census technique.

1. Total Count. Total nest counts were made for Pelagic Cormorants (Phalacrocorax pelagicus), Black Oystercatchers (Haematopus bachmani) and Glaucous-winged Gulls (Larus glaucescens), unless nests were inaccessible. Population estimates equal the number of nests counted. For burrowing species, total counts were made when all burrows were accessible and easily tallied during the exploration of the island. This method was appropriate on small islands with few burrows, or on larger islands with scattered burrows around perimeter areas. Population estimates equal the number of burrows counted multiplied by the median occupancy rate (Rodway et al. 1988), rounded to the nearest ten. Nesting populations are estimated differently for surface and burrow nesting species because surface nests are constructed each year and represent a current reproductive effort, whereas burrows can persist for a number of years even when not being used. Within the text, lists of nests counted use these abbreviations: E - egg; Y - young.

Total numbers of Pigeon Guillemots (Cepphus columba) sighted around colonies were counted, but no standardized observation techniques were employed (see Nettleship 1976), and no attempt was made to estimate actual nesting populations.

2. Partial Count. On small islands where a total count was not feasible or practical, but the colony area or population was too small to warrant sampling by transects, burrows in representative portions of the island were counted and figures were extrapolated for the rest of the area.

3. Line Transects With Quadrats.

3.1. **Transect location.** After the colony was mapped during exploration, equally spaced, parallel transects were run throughout colony areas. On Pine Island, which has a circular shape and has burrowing only around the perimeter, transects were laid out upslope, generally perpendicular to the shoreline. On other colonies, where burrows sometimes extended into the middle of the islands, transects were laid out along parallel bearings to avoid

convergence or divergence inland. Such transects were run across the long axis of an island, to insure representative sampling of variations in species distribution and burrow density. Transect spacing ranged from 22 m to 150 m apart, depending on the size of the colony. We attempted to sample 1% of the area of a colony. That value was the maximum sampling effort we found possible within a practical time frame. Transects were placed half a "spacing" distance from the borders of a colony, and unless the colony edge was at the island shore, a transect was run outside the edge to insure that our mapping was accurate, and to provide a sample of "non-colony" so that changes in colony extent could be reliably interpreted on future surveys. Transects were located either by measuring the spacing distance along a line perpendicular to the transect bearings (along the shore if this was feasible), or by locating reference points plotted on air photos (for areas where the topography was extremely dissected or impassable).

3.2. **Quadrats:** Quadrats were set at predetermined intervals along transect lines. They were spaced at 20 m intervals on Pine Island and 15 m intervals on other colonies, with the first quadrat placed at the shore edge of the vegetation. Plots size ranged from 1x1 m to 5x5 m, and was selected so that an average of at least one burrow occurred in each quadrat. The density of burrowing encountered in most areas was best sampled with smaller, more frequent plots (Savard and Smith 1985).

Burrows were counted within each quadrat to determine burrow density. Burrow characteristics were recorded: location (ie, under roots, stumps, logs, grass tussocks, etc.), accessibility (whether it was obscured, or obstructed), and signs of activity (droppings, feathers, etc.), both at the entrance and in the tunnel. If within one arm's length, entrances connected into the same tunnel, only one burrow was recorded and the number of entrances was noted. Habitat parameters were measured: distance from shore, altitude, slope, percent and species composition of ground cover, shrub cover, and forest canopy. To place the quadrat in the context of the overall habitat, tree species, percent composition, and average size (dbh), and general terrain features were documented for the area surrounding each quadrat within a radius equal to half the distance between quadrats. Evidence of predation (eggshells, carcasses, feather piles) within each quadrat was recorded, and the overall density of predation evidence was calculated in the same fashion as burrow density.

3.3. **Colony area:** Colony area was defined to include all portions of an island where burrows with recent signs of activity (droppings, feathers, regurgitated food, fragments of eggshell or egg membrane, worn entrances or tunnels, excavation, or fresh nesting material) were located. If burrows were located, but no signs of recent activity were observed in an area, the colony was considered abandoned. If there were no burrows within a quadrat, the surrounding area was searched for colony evidence to determine

if the plot fell within the colony and should be used in density calculations. If no burrows were found within a distance halfway to adjacent quadrats along the transect, nor within a lateral radius half the distance to adjacent transects, then that area was excluded from the colony and the plot data was not used in density calculations. If burrows and signs of activity did occur within this range, then the area was considered colony and the plot data was used as part of the burrow density sample. If active looking burrows were observed in the vicinity of one quadrat, but were absent from the area surrounding an adjacent quadrat, the colony boundary was delimitated half way between the two quadrats, unless an obvious border was encountered. The same criteria was applied between transects. On most colonies, colony boundaries were distinct and precise measurements of the extent of colony were often possible.

Distance, elevation, and slope measurements taken along the transects, as well as during the exploration, were used to draw colony areas on detailed topographic maps or air photos. The horizontal surface area of the colony was measured on that map with a compensating polar planimeter. Adjusting for slope, the area of the colony was given by:

$$C_s = A_m T^2 (\cos \bar{X})^{-1}$$

where C_s is the colony surface area, A_m is the area on the map, T is the scale of the map, and $\bar{X}$ is the mean slope along the transects. Our colony area calculations take into account the average uphill slope, but not the undulations between quadrats or between transects. Therefore our calculations give a conservative estimate of the total surface area available to the birds for nesting.

3.4. **Burrow density:** Data from all plots located within colony area were used to calculate an average burrow density for the colony.

3.5. **Occupancy:** The percentage of burrows that actually contained nesting birds was determined by complete examination of a sample of burrows. If an adult, an egg, a chick, or freshly hatched egg membrane was found, the burrow was considered occupied. Burrows were considered empty if all tunnel branches were explored and none of the above were found. Signs such as a well worn entrance or droppings were not used to distinguish between occupied and empty burrows. Exploring burrows longer than an arm's reach required digging one or more access holes until the end was reached. Dug holes were immediately patched over. The contents of many burrows were impossible to determine because they extended under roots or fallen trees or into cavities within tree bases. To minimize disturbance, adults were not pulled from burrows except to confirm species identification.

Due to time constraints we did not attempt to explore burrows in every quadrat surveyed, but selected quadrats from as many areas of the colony as time permitted and explored every burrow in each quadrat selected. To determine storm-petrel occupancy and species composition on Storm Islands in 1987, we randomly selected one plot along each transect running through areas where they were nesting, and then explored the burrows in that plot until we knew the contents of at least five burrows. On Rhinoceros Auklet colonies, we chose separate areas where burrows were frequent and a sample could be obtained within a reasonable time frame. To minimize the bias within those areas, we started from a central point and explored every burrow encountered within an expanding radius until we had an adequate sample. The size of those areas was not measured. Their locations are indicated on colony maps.

When we had data on occupancy from several plots, we calculated the occupancy rate according to the formula:

$$R = \frac{\bar{x}}{\bar{y}}$$

where x is the number of occupied burrows in each quadrat, and y is the total number of burrows of known status in each quadrat.

The variance of R is calculated from:

$$Var(R) = \frac{\bar{x}^2}{\bar{y}^2} \left[\frac{s_x^2}{\bar{x}^2} + \frac{s_y^2}{\bar{y}^2} - \frac{2s_{xy}^2}{\bar{x}\,\bar{y}} \right]$$

where s_x is the standard error of $\bar{x}$, s_y is the standard error of $\bar{y}$, and s_{xy}^2 is the covariance of $\bar{x}$ and $\bar{y}$ (Kendall and Stewart 1963). The standard error of R is then the square root of Var(R).

We did not determine occupancy rates on small Cassin's or Rhinoceros auklet colonies. To estimate a nesting population on those colonies we used a median occupancy rate based on data from all other colonies of that species surveyed in British Columbia (Rodway *et al.* 1988).

3.6. **Total burrows and current nesting estimates:** The total number of burrows (B) is the product of the overall average density of burrows as determined in the quadrats and the total area of the colony. B multiplied by the occupancy rate, (R) gives an estimate of nesting pairs (P). Calculations are quoted plus or minus one standard error.

The variance of P is calculated from

$$Var(P) = B^2\, Var(R) + R^2\, Var(B) - Var(B) * Var(R)$$

The standard error of P is then the square root of Var(P).

4. Distinguishing species:

The burrows of different species are often mixed. This presents problems for the surveyor when burrow contents cannot be determined. Identification of burrows must then be based on indicative signs found in the burrow or at the burrow entrance. We developed a set of criteria for distinguishing burrows of storm-petrels, Cassin's Auklets and Rhinoceros Auklets: size of entrance; wear at the entrance; droppings in and around the burrow entrance; regurgitated food (for Cassin's Auklet); feathers found in the burrow; eggshell fragments found in the burrow; and odour.

Storm-petrels often nest in conjunction with Cassin's Auklets. Little difficulty is usually encountered differentiating storm-petrel burrows according to size (5-7 cm in width). The musty odour of petrels is also helpful.

Cassin's Auklets and Rhinoceros Auklets are found nesting in the same areas. Cassin's Auklet burrows are generally smaller (10-12 cm in width), while larger burrows (12-15 cm in width) generally belong to Rhinoceros Auklets. Droppings, regurgitated food, fragments, and feathers provide more conclusive evidence for differentiating these species. Rhinoceros Auklets have relatively clean burrow entrances. Their droppings are large, generally globular, pale yellow with black, viscous blobs, and are often deposited to one side of the burrow entrance. Cassin's Auklets leave white fecal streaking along the approach and into the entrances of their burrows. Cassin's Auklet droppings also have a more arresting odour, as does their regurgitated food, some of which they invariably lose at the entrance to their burrows when they are delivering it. Abdominal feathers (which are often lost in the burrows) of each species can be distinguished by the colour pattern of their plumules (size is not reliable). Cassin's Auklet plumules are mostly dark with a tip of white. The colour of the Rhinoceros Auklet plumule is uniform greyish white and is similar to that of the base of the main feather. Eggshell fragments of Cassin's Auklets and Rhinoceros Auklets are both white and are inseparable unless a major portion of the shell is present and can be distinguished by size.

5. Predation:

During exploration, notes were kept of all signs of predation or mortality encountered. Areas around Bald Eagle, Peregrine Falcon, and Common Raven nests, and around river otter runs and

dens were examined in detail. This gave an indication of the degree and the kind of species being preyed upon.

6. Staging:

Near dusk, prior to flying into their nesting slopes, Rhinoceros Auklets typically flock up on the water adjacent to their colony. We made boat trips around the colonies on Storm Islands, during which we kept records of numbers and locations of all birds sighted. Observations around Pine Island were made from shore.

7. Time:

Times quoted are Daylight Savings Time. Subtract one hour from Daylight Savings Time to get Pacific Standard Time.

COLONY ACCOUNTS

QS-010 BREMNER ISLET 92 M/4

Location: Off the south end of Burnett Bay.
51°05'51"N 127°41'20"W

Land status: Crown land.

Date of visit: 5 July (1830-2100 h) and 7 July (1400-1600 h) 1982.

Colony access: Drop-off from boat.

Observers: M.S. Rodway, A. Bell, C.M. Rodway.

Census method: Total count. The nest count for gulls was begun on 5 July, but was completed on 7 July due to the onset of heavy rain on 5 July.

Description: Perimeter areas are bare rock with some low cliffs. Higher portions, which rise to 17 m elevation, are grassy, crowned with a small stand of windswept spruce.

Nesting species:

Pelagic Cormorant: Cormorants were nesting along cliff faces in a cleft that runs north-south across the western side of the island. We counted 16 nests (Table QS010-1). Adults were sitting on nests, and 72 immature birds were roosting.

Table QS010-1. Pelagic Cormorant nests on Bremner Islet in 1982.

Empty	1E	2E	3E	4E	5E	Total
6	3	3		3	1	16

Black Oystercatcher: Six adults were present, but no nests were found.

Glaucous-winged Gull: We counted 144 nests on rocky areas around the islet (Table QS010-2). Nests were made of grass. Many young were just hatching.

Table QS010-2. Glaucous-winged Gull nests on Bremner Islet in 1982.

Empty	1E	2E	3E	2E1Y	1E2Y	1E1Y	1Y	2Y	3Y	Total
15	2	11	48	6	11	6	5	13	27	144

Pigeon Guillemot: Guillemots were nesting in crevices and under rocks. We found 6 nests: 2 with 1 egg and 4 with 2 eggs. There were 29 adults present: 14 sitting on rock in the interior of the island, and 15 on the water near shore.

Other birds and mammals sighted

Western Sandpiper - 15

QS-020 McEWAN ROCK 92 M/4

Location: West of Bramham Island. 51°03'30"N 127°37'47"W

Land status: Crown land.

Date of visit: 7 July 1982 (1600 h).

Colony access: Drop-off from boat.

Observers: M.S. Rodway, A. Bell, C.M. Rodway.

Census methods: Total count.

Description: This steep-sided rock is mostly bare with some patches of grass on top.

Nesting species:

Pelagic Cormorant: Cormorant nests were located on the north face of the island. We counted 14 nests: 3 empty, 1 with 1 egg, 1 with 2 eggs, 2 with 3 eggs, 2 with 4 eggs, and 5 unknown. There were 21 adults and 20 immatures present.

Glaucous-winged Gull: We counted 44 nests (Table QS010-2). Nests were made of grass. Many young were just hatching. One dead young was seen in one nest.

Table QS020-1. Glaucous-winged Gull nests on McEwan Rock in 1982.

Empty	1E	2E	3E	2E1Y	1E2Y	1E1Y	1Y	2Y	3Y	Total
3	4	3	24	2	2	1		2	3	44

QS-030 STORM ISLANDS 92 M/4

Location: North of Pine Island. 51°01'30"N 127°43'W

Land status: Except for the area within Indian Reserve No. 5, these islands became part of the Duke of Edinburgh Ecological Reserve in 1988.

Date of visit: 22 July - 2 August 1987.

Colony access: Drop-off from boat for all islands except #19 where boat landings are possible on the small beach on the northwest corner.

Base camp: Camping is possible on the small beach on the northwest corner of island #19, except on very high tides which wash the entire beach.

Observers: M. Lemon, M. Rodway, B.Carter, R. Chaundy, S. Wetmore (22-28 July).

Census method: 167 quadrats, 3x3 m, for Rhinoceros Auklets, and 167 quadrats, 1x1 m, for storm-petrels were surveyed at 15 m intervals along 23 parallel transects (Table QS030-1; Fig. QS030-

1). Plots for Rhinoceros Auklets and storm-petrels were surveyed at the same locations, the smaller plot lying within one corner of the larger plot. Transects were spaced 100 m apart through the entire length of vegetated habitat along the Storm Islands chain (ie., the vegetated habitat was treated as continuous). Transects were run across the smaller islands with their beginnings alternating between the north and south shores and their bearings alternating between 30° and 210°. On island 19, transects were run through colony areas on either edge but not across the centre of the island. To maintain the same sampling regime as that along transects that were run right across other islands, we alternated the beginnings of the transects so that the plot at shore occurred alternately on the north and south sides. Then, for each transect, we randomly chose a distance between 0 and 15 m from shore to place the beginning plot for the extension of that transect on the opposite shore.

To determine storm-petrel occupancy and species composition, we randomly selected one plot along each transect running through areas where they were nesting, and then explored the burrows in that plot until we knew the contents of at least five burrows. This gave us samples in a variety of habitats from which we hoped to discern possible differences in habitat use by Fork-tailed and Leach's storm-petrels. For Rhinoceros Auklets, we determined occupancy only on island 19 (Fig. QS030-1) and extrapolated for the rest of the chain. This was due to the time involved in "digging" Rhinoceros Auklet burrows (1-2 h per burrow), and the efficiency of concentrating the efforts of the whole crew at one time and in one place. We did "dig" burrows in three distinct habitat types: grass; forbs/salmonberry; and bare litter, in an attempt to make the sample as representative as possible.

We made a total count of Glaucous-winged Gull nests, and counted all Pigeon Guillemots around the islands. Unless otherwise noted, Black Oystercatchers and Glaucous-winged Gulls were surveyed on 31 July at 1445-1710 h. Pigeon Guillemots were counted around all islands on 23 July between 1145 and 1330 h.

Ten Leach's Storm-Petrels eggs were collected on island 17 for pesticide analysis.

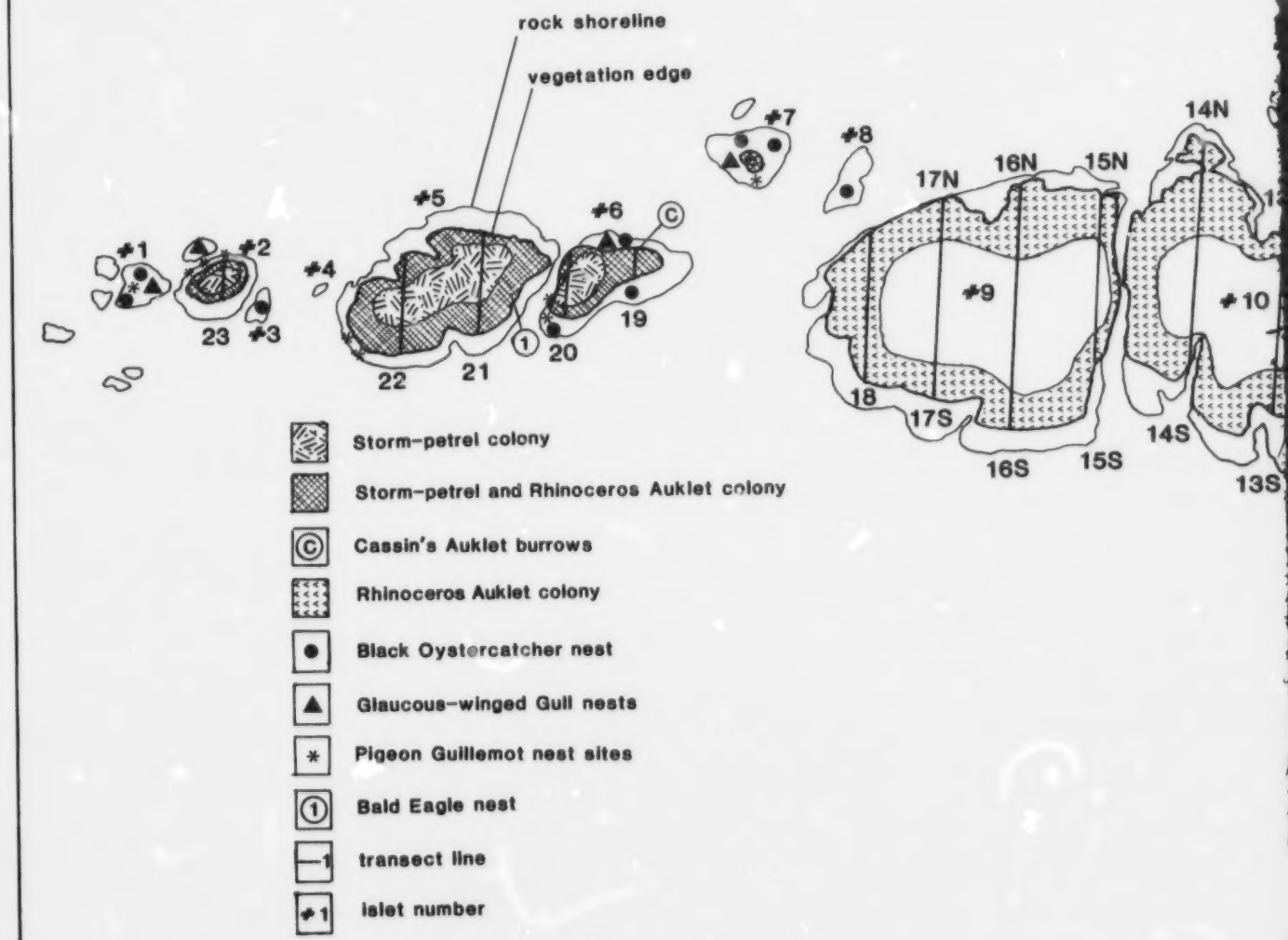

Figure QS030-1. Seabird colony areas and transect locations on Storm Islands in 1987.

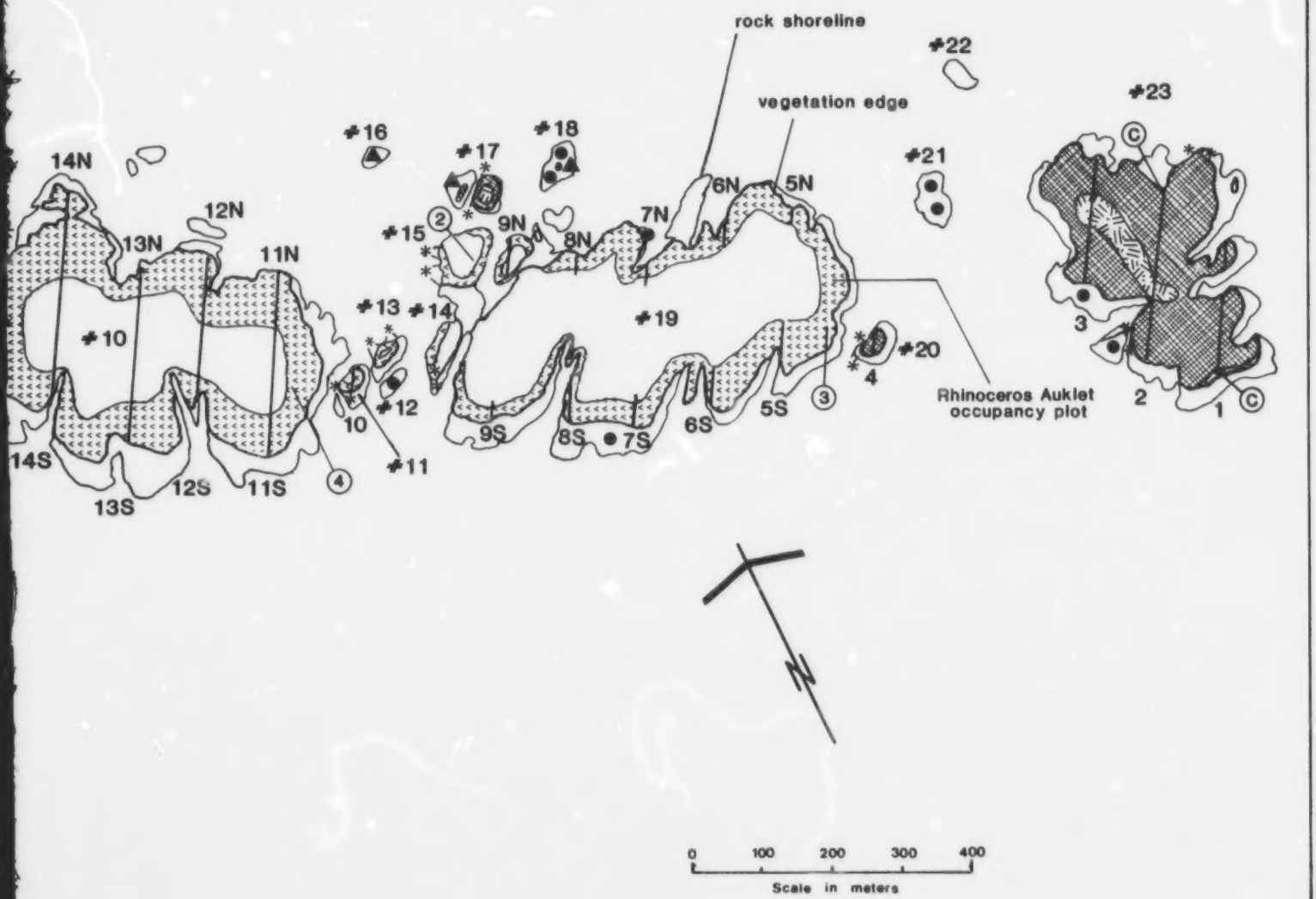
rock shoreline
vegetation edge
Rhinoceros Auklet
occupancy plot
14N
13N
12N
11N
10
14S
13S
12S
11S
16
17
18
15
9N
8N
7N
6N
5N
13
14
19
12
11
9S
8S
7S
6S
5S
22
21
20
23
3
4
2
1
0
100
200
300
400
Scale in meters

Table QS030-1. Transect parameters on Storm Islands in 1987.

Transect	Bearing (°)	Total length (m)	Elevation (m) Beg.	End	Max.	Average slope (°)	Range of slope (°)
1	30	158	10	7	20	19	10-48
2	210	254	10	10	30	15	2-32
3	30	177	5	6	10	8	0-20
4	210	21	4	7	7	7	5-8
5S	30	56	6	10	10	15	5-20
5N	210	23	8	12	12	28	28
6N	210	26	18	28	28	45	30-60
6S	30	46	U[a]	U	U	25	10-40
7S	30	30	U	U	U	12	3-20
7N	210	30	25	30	30	18	18
8N	210	25	6	8	8	13	5-31
8S	30	15	U	U	U	15	15
9S	30	17	U	U	U	24	22-25
9N	210	51	U	U	U	15	15
10	210	30	U	U	U	12	12
11[b]	210	267	5	20	20	11	5-20
12[c]	30	204	U	U	U	11	0-37
13[d]	210	263	12	13	25	17	5-32
14[e]	30	284	20	8	25	15	5-45
15[f]	210	200	10	5	18	19	2-40
16[g]	30	353	15	15	20	12	0-35
17[h]	210	272	10	20	10	13	0-25
18	30	201	U	U	8	18	2-45
19	210	24	6	8	8	10	10
20	30	58	15	15	16	30	2-52
21	210	127	12	22	25	16	5-40
22	30	119	15	18	26	15	5-30
23	210	63	15	15	25	20	5-30

[a] not measured.
[b-h] no plots surveyed between: [b] 108 and 210 m; [c] 17 and 105 m; [d] 62 and 210 m; [e] 32 and 165 m; [f] 77 and 165 m; [g] 47 and 255 m; [h] 47 and 225 m.

Description: The Storm Islands are a compact chain of 23 islands and rocks at the western entrance of Queen Charlotte Strait (Fig. QS030-1). They have a total area of 60 ha and rise to a maximum elevation of 70 m. The shores of the islands are steep rock, with no beaches except for three small pocket beaches on island 19. The larger islands are dissected and separated by gorges and crevices running perpendicular to the length of the chain, but there are few cliffs outside of these gorges. The three large, central islands have interiors of primarily salal under hemlock, redcedar and spruce. Perimeter areas of these central islands, especially

towards the east and west ends, and much of the area on the smaller vegetated islands are covered with dense salmonberry under spruce. Open patches of grass and other herbaceous growth occur along the edges of many of the smaller islets. More detailed habitat descriptions are given for each island:

1. Mostly bare rock with some grassy patches.
2. Bare rock around perimeter. Elymus around edge of vegetation changing to Montia and Maianthemum and then to salmonberry within 1-5 m from vegetation edge.
3. Bare rock.
4. Bare rock.
5. Covered with salmonberry and some elderberry under spruce, with grassy (Elymus) fringes.
6. Extensive rocky shore except on the north-west side facing island 5 where the vegetation overhangs the steep-sided gorge between the two islands. The vegetated area is mostly salmonberry under spruce with 1-5 m fringes of grass around the perimeter. Some elderberry occurs amongst the salmonberry, and in the few areas where the salmonberry is not prohibitively thick, moss and forbs cover the ground.
7. Mostly bare rock with an area of vegetation about 30 m wide on the top. The vegetation is salmonberry under a small stand of stunted spruce, with Elymus and Maianthemum on the edge.
8. Bare rock with a few tufts of grass.
9. The interior of most of the island is covered with salal under spruce and hemlock. Perimeter slopes, especially on the western end, are dense salmonberry with some huckleberry and currant under spruce, and have grassy fringes.
10. Salal under hemlock and spruce extends across the interior of the island. The more open perimeter slopes are covered with dense salmonberry and some elderberry under spruce, with grass on the outer edges. Pockets of open, bare litter understory, occur between the salmonberry and salal.
11. This steep-sided islet has an area of vegetation about 30x40 m, mostly thick salal and salmonberry under spruce, hemlock and crabapple, with fringes of grass and Maianthemum. On the southwest corner is an extensive patch of Maianthemum. Rhinoceros Auklets have worn the edge slopes bare along the southeast side.
12. Rocky islet with small patch of vegetation (~10 m in diameter). Vegetation is thick salal, crabapple, sitka alder, few short spruce trees and twinberry, with fringes of grass, crowberry and forbs. The rock is steep on the northwest side.
13. Steep-sided islet with a 30x40 m area of salal and salmonberry under spruce. Grass, Maianthemum and moss grow on the fringes.
14. Steep-sided islet covered with dense salal and salmonberry under spruce and hemlock, with a small open area of Maianthemum, grass, and other forbs on an isolated rocky knob on the mid-northwest side.

15. Covered primarily with salal under spruce and hemlock, mixed with huckleberry, salmonberry, twinberry, crabapple, false azalea, and thimbleberry. Small open patches of sword fern and bare ground occur near shore, and grass grows on the fringes. The shores are steep rock.

16. Bare rock.

17. Steep, rocky sides, with a top of mostly salmonberry under spruce. Salal, bracken fern, and twinberry occur in the interior, and there are fringes of grass, Maianthemum and other forbs.

18. Small, rocky knob with 3x5 m crown of short, windswept salal and spruce. On the edges are patches of crowberry, grass, Maianthemum, Conioselium and other forbs.

19. Salal under hemlock and spruce extends across the interior of the island to within 20-25 m of the shore edge. The more open perimeter slopes are covered with dense salmonberry under spruce, with grass and Maianthemum on the outer edges.

20. Thick salmonberry under a few spruce, with some grass and forbs on the fringes. There is a small cliff on the northwest side.

21. Mostly rock with tufts of grass.

22. Bare rock.

23. Most of the island is covered with thick salmonberry up to 2 m tall under a forest of spruce. There is an eroded grassy (Elymus) slope on the southwest side and open areas of Maianthemum and Saxifraga on the west and east sides.

Nesting species:

Storm-petrel: Storm-petrels were nesting over most of the vegetated areas of islands at either end of the Storm Islands chain (Tables QS030-2,3; Fig. QS030-1). Scattered, sparse burrows were encountered on the central islands: we found a few, sporadic storm-petrel burrows at the western end of island 9 along transect 18, one possible burrow on the northeast tip of island 12, one burrow with signs of recent digging, 2 m from the edge of vegetation on the northwest corner of island 14, and a few petrel burrows under the salal about 25 m from shore on the southeast corner of island 15. There were a few burrows in the vegetated area of island 18, and sporadic burrowing occurred on the east end of island 19 within 30 m of shore, on slopes of grass, Maianthemum, other forbs, and salmonberry under spruce.

Burrows were located primarily under forbs, especially Maianthemum, in open ground, and under mossy deadfall (Table QS030-4). Fork-tailed Storm-Petrel burrows contained chicks at the time of our survey. Leach's Storm-Petrels were incubating eggs, one of which had just hatched (Table QS030-5). In our occupancy plots, we found Fork-tailed Storm-Petrels only at the northwest end of the Storm Islands chain, they appeared to be absent from islands at the southeast end. We found one Fork-tailed Storm-Petrel burrow in the

pesticide plot on island 17. Leach's Storm-Petrels occurred at both ends (Table QS030-5). Interestingly, only Leach's Storm-Petrels were found on nearby Reid Islets off the southeast end of Storm Islands. Fork-tailed Storm-Petrel burrows tended to be longer (80.0 ± 6.9 cm; n = 9) than Leach's Storm-Petrel burrows (53.8 ± 3.1 cm; n = 38).

A few Fork-tailed and Leach's storm-petrels were heard calling around our camp on the nights of 22 to 24 July, beginning between 2308 h and 2330 h and heard periodically throughout the night.

1987 Population estimate:

Number of sample plots:	68 (68 m^2 - 0.1% of colony)
Average density:	26,000 ± 2510 burrows/ha
Colony area:	10.3 ha
Total burrows:	268,967 ± 25,966
1987 Occupancy rate:	90.4 ± 2.9 (47 of 52 known)
Ratio of FTSP:LSPE:	9:34 (21%:79%)
1987 Nesting population:	
Fork-tailed Storm-Petrel:	50,835 ± 5177 pairs
Leach's Storm-Petrel:	191,235 ± 19,476 pairs

Table QS030-2. Extent of storm-petrel and Rhinoceros Auklet colony along transects on Storm Islands in 1987.

Transect	Storm-petrel				Rhinoceros Auklet			
	Dist. along transect (m)	Distance from nearest shore Min. (m)	Max. (m)	Range of elevation (m)	Dist. along transect (m)	Distance from nearest shore Min. (m)	Max. (m)	Range of elevation (m)
1	8-158	0	26	6-20	0-158	0	26	6-20
2	0-254	0	83	10-30	0-158	0	83	10-30
					188-254	0	30	8-10
3	0-177	0	57	5-10	0-83	0	35	5-8
					127-177	0	35	6-8
4	0-21	0	10	4-7	0-21	0	10	4-7
5S					0-56	0	44	6-10
5N					0-23	0	23	8-12
6N					0-26	0	17	18-28
6S					0-46	0	13	U[a]
7S					0-25	0	25	U
7N					0-20	0	20	25-30
8N					0-22	0	22	6-8
8S					0-15	0	8	U
9S					0-14	0	14	U
9N					0-15	0	15	U
10					0-10	0	10	U
11N					0-78	0	39	5-10
11S					0-62	0	37	15-20
12S					0-22	0	20	U
12N					0-102	0	48	U
13N					0-48	0	32	12-22
13S					0-55	0	52	13-20
14S					0-18	0	15	20-22
14N					0-121	0	65	8-22
15N					0-66	0	17	10-16
15S					0-37	0	17	5-14
16S					0-44	0	40	15-16
16N					0-101	0	61	15-20
17N					0-55	0	52	10-12
17S					0-47	0	47	10-20
18					0-200	0	52	U
19	0-24	0	12	6-8	0-24	0	12	6-8
20	0-58	0	18	15-16	0-8	0	8	15
21	0-127	0	52	12-25	0-20	0	20	12-15
					83-127	0	37	22-25
22	0-119	0	52	15-26	0-37	0	37	15-24
					83-119	0	16	22-25
23	0-60	0	30	15-25	0-7	0	7	15-17
					53-60	0	7	15-17

[a] not measured.

Table QS030-3. Number of storm-petrel burrows in 1x1 m plots along transects on Storm Islands in 1987. Plots considered outside colony are indicated by a dash.

Plot	Transect 1	2	3	4	19	20	21	22	23
1	-	2	0	4	2	0	0	2	5
2	2	2	3	3	1	3	2	5	6
3	2	0	2			0	3	4	1
4	3	5	0			3	9	4	4
5	0	4	0				4	5	-
6	1	5	1				3	6	
7	4	4	0				2	6	
8	0	4	3				5	2	
9	0	0	2				7		
10	0	2	1						
11	0	5	0						
12		2	0						
13		4							
14		3							
15		4							
16		4							
17		2							

Table QS030-4. Habitat locations of storm-petrel and Rhinoceros Auklet burrow entrances along transects on Storm Islands in 1987.

Habitat locations	Storm-petrel		Rhinoceros Auklet	
	Number of burrows	Percent of total	Number of burrows	Percent of total
Forbs	128	35	37	7
Open ground	86	23	59	11
Mossy deadfall	79	21	126	24
Shrubs	32	9	40	8
Dead tree roots	11	3	46	9
Grass	9	2	60	12
Into bank	8	2	45	9
Stump	7	2	37	7
Live roots	6	2	49	9
Tree base	4	1	19	4

Table QS030-5. Occupancy of storm-petrel burrows on Storm Islands in 1987.

Location Tran	Plot	Date	Empty	Cold egg	Warm egg	Fork-tailed Adult	Fork-tailed Adult +egg	Fork-tailed Chick	Leach's Adult	Leach's Adult + egg	Leach's Adult +chick	Total occup	Total known
Occupancy plots along transects:													
1	7	23 Jul							2	3		5	5
2	10	23 Jul	1							5		5	6
3	12	30 Jul	1		1					2	1	4	5
4	2	24 Jul		3						4		7	7
19	2	26 Jul	1					1	1	4		6	7
20	4	26 Jul	1					3[a]		2		5	6
21	6	26 Jul							2	3		5	5
22	4	26 Jul						1	1[b]	3		5	5
23	2	25 Jul	1					4		1		5	6
Total			5	3	1			9	6	27	1	47	52
Incidental burrows along transects:													
1	3	23 Jul								1			
1	5	23 Jul								1			
2	4	23 Jul								2			
2	6	23 Jul								1			
19	1	26 Jul							1[b]				
20	1	26 Jul								1			
20	3	26 Jul		1									
22	1	26 Jul					1						
23	3	25 Jul								2			
23	4	25 Jul				1				1			
Pesticide plot:													
Island 17		26 Jul					1			10			

[a] one chick had just fledged.
[b] two adults.

Pelagic Cormorant: We found no sign of nesting by cormorants.

Black Oystercatcher: We estimated 18 pairs of oystercatchers nesting on Storm Islands (Table QS030-6; Fig. QS030-1). Thirteen nests were found and 5 other pairs were suspected nesting because of their agitated behaviour, which suggested the presence of chicks. We also suspected chicks in the vicinity of some empty

nests found. Young were present at most nests, one egg in the nest on islet 1 was pipping. Most nests were made of rock and shell chips, including abalone, mussel, limpet and barnacle shells, on bare rock. The nest on islet 3 was a bowl in a small tuft of grass, lined with pebbles and limpet shells. On island 8, the scrape was a dirt bowl layered with limpet and mussel shells. We found one broken egg near the empty scrape on island 18. One adult on the south side of island 23 was carrying food on 23 July.

During the survey on 31 July, we counted a total of 66 oystercatchers, including a flock of 16 flying around island 6 and a group of 8 roosting on island 16.

Table QS030-6. Black Oystercatcher nests on Storm Islands in 1987.

Islet	Empty	1E	2E	1Y	2Y	Suspected	Total
1	1		1				2
3					1		1
6	2[a]				1		3
7	1[a]					1[a]	2
8	1[a]						1
12	1[a]						1
18	1	1					2
19						2[a]	2
21					2		2
23						2	2
Total	7	1	1		4	5	18

[a] young suspected.

Glaucous-winged Gull: We counted 61 gull nests, most of which were located on islands 1 and 7 (Table QS030-7; Fig. QS030-1). Nests on island 1 were made of grass and some seaweed. On island 7, nests were made of grass, ferns, moss, and few twigs. Isolated nests on other islands were built of grass. Many empty nests were worn with feathers about, and probably had associated young that were not located. Most young had pin feathers and were wandering from the nests. One depredated egg below one nest with 2 young, and a large herring were found on island 1. We found one well used nest attended by two adults on the north rocks of island 2. Young were suspected but not located. On island 6, one pair was nesting on a rock pinnacle on the mid-northeast side. Two downy young (~20cm long) were wedged in cracks below the nest. There were two worn nest platforms plus an unfinished nest in this area, but only one pair appeared to be nesting.

Table QS030-7. Glaucous-winged Gull nests on Storm Islands in 1987.

Islet	Empty	1E	2E	3E	2E1Y	1E2Y	1E1Y	1Y	2Y	3Y	Total
1	14		3	7			1	1	5		31
2	1[a]										1
6									1		1
7	10	1	5	7		1			1		25
16	1										1
17										1	1
18		1									1
Total	26	2	8	14		1	1	1	7	1	61

[a] young suspected.

Pigeon Guillemot: We counted a maximum of 111 birds around the Storm Islands (Table QS030-8). Guillemots were nesting in burrows on the edge of the vegetation above steep shore rock on islands 6, 11, 13, 14, 15, 17, and 20 and in crevices in other areas (Fig. QS030-1). The contents of two nests were determined on 31 July: one with one egg in a crevice on island 7, and one with a cold egg in a burrow on island 13. Adults were seen carrying fish into burrows on 23, 24 and 26 July. One broken eggshell was found on island 14.

Table QS030-8. Numbers of Pigeon Guillemots counted around the Storm Islands in 1987.

Island	Adults	Nests 1E
1	1	
2	12	
5	3	
6	12	
7	15	1
11	18	
13	1	1
14	(same birds as #11)	
15	10	
17	12	
20	17	
23	10	
Total	111	

Cassin's Auklet: We found scattered Cassin's Auklet burrows in grassy areas on the perimeters of islands 6 and 23 (Fig. QS030-1). Burrows were too sporadic to sample with line transects. We estimated a breeding population of 300 pairs, most nesting on island 23. Breeding was not confirmed, but burrows were worn with droppings and regurgitated food at their entrances.

Rhinoceros Auklet: Rhinoceros Auklets were nesting in perimeter areas of most islands, extending as far as 83 m, but generally less than 40 m, from shore (Tables QS030-2,9; Fig. QS030-1). Most burrows occurred under mossy deadfall, grass or in open ground (Table QS030-4). The average length of burrows was 143.6 $\pm$ 10.3 cm (n = 33). Most burrows examined in the occupancy plot on 1 August contained large chicks (23). One occupied burrow held just an adult; 7 of the 31 known burrows were empty.

1987 Population estimate:

Number of sample plots:	147 (1323 m^2 - 0.6% of colony)
Average density:	3900 $\pm$ 330 burrows/ha
Colony area:	24.0 ha
Total burrows:	93,686 $\pm$ 7927
1987 Occupancy rate:	77% (24 of 31 known)
1987 Nesting population:	72,138 $\pm$ 6104 pairs

Staging and nocturnal activity: Very little vocalization was heard around the camp. Some Rhinoceros Auklets were heard calling at 0300 h on 23 July.

No staging concentrations were seen. On 28 July between 2100 and 2130 h small numbers of Rhinoceros Auklets were scattered with fish in their bills from the south side of Storm Islands to about 2 km offshore of the west end and along the north side to camp. Twenty-six birds were seen flying in small groups and a few were scattered on the water. On 29 July, 140 birds were seen, single and in flocks of 10 to 20, 1 to 3 km north of Storm Islands at 2130 h. Single birds had food in their bills but birds in flocks did not.

Table QS030-9. Number of Rhinoceros Auklet burrows in 3x3 m plots along transects on Storm Islands in 1987. Plots considered outside the colony are indicated by a dash.

	Transect														
Plot	1	2	3	4	5S	5N	6N	6S	7S	7N	8N	8S	9S	9N	10
1	15	1	0	0	3	11	8	13	0	3	4	5	6	0	3
2	8	8	2	5	5		0	5	0		2				
3	6	4	1		3			1							
4	3	5	8		4										
5	6	4	1												
6	2	1	2												
7	6	0	-												
8	11	1	-												
9	18	0	-												
10	11	1	2												
11	10	1	7												
12		-	5												
13		-													
14		1													
15		2													
16		0													
17		8													

Table QS030-9. (cont'd)

	Transect														
Plot	11N	11S	12S	12N	13N	13S	14S	14N	15N	15S	16S	16N	17N	17S	18
1	7	12	0	5	9	14	4	2	4	0	7	19	5	0	4
2	4	4	1	3	3	7	0	2	5	4	1	8	5	4	2
3	1	2		3	4	8	-	7	1		1	4	4	2	5
4	1	1		1	2	1		4	1		-	0	1	3	4
5	0			1	-			2	2			1			1
6	0			5				2				2			2
7				0				0				2			2
8								1							2
9															2
10															1
11															0
12															4
13															1
14															9

Table QS030-9. (cont'd)

Plot	Transect 19	20	21	22	23
1	3	4	0	2	0
2	4	-	0	2	-
3		-	-	0	-
4		-	-	-	0
5			-	-	
6			-	-	
7			1	2	
8			0	5	
9			4		

Tufted Puffin: We saw no puffins or evidence of nesting by puffins.

Predation: There was very little evidence of predation in the colony. We found feather piles of Leach's Storm-Petrel (1), Cassin's Auklet (1) and Rhinoceros Auklet (3), 1 Fork-tailed Storm-Petrel wing, 2 unidentified wings, and 1 eagle pellet in surveyed quadrats. We did not calculate predation rates. Falcons were observed catching Northern Phalaropes feeding in the area.

Associated species:

Pelagic Cormorant - 1 immature on 23 July on islet 7 and 4 immatures on islet 18 on 31 July.

Bald Eagle - 5 adults and 2 immatures on 23 July. 4 nests were found, none of which appeared active (Fig. QS030-1):

1. 10 m up in a 20 m snag, 35 m from shore. No activity on 23 July.
2. 25 high on a side branch of a 35 m spruce near shore. No activity on 31 July.
3. 16 m high in a 30 m spruce 12 m from shore. No activity on 27 July.
4. 25 m high in 40 m spruce, east of transect 11. No activity on 24 July.

Peregrine Falcon - 1 male and 1 female on islet 19 on 27 July. We watched both of them catch Red-necked Phalaropes.

Marbled Murrelet - 1 in winter plumage on 23 July south of islet 6 and 1 in winter plumage off islet 16 on 25 July.

Northwestern Crow - Maximum of about 20 birds seen on 23 July south of islets 5 and 6.

Common Raven - 2 on 23 July west of islet 19.

Other birds and mammals sighted:

Harlequin Duck - 2 on 25 July off islet 16, one of which was a male in eclipse plumage.

Wandering Tattler - 2 on 23 July on islet 23 and 1 on 31 July on islet 1.

Spotted Sandpiper - 2 on 24 July on islet 9.

Black Turnstone - 25 on 31 July.

Red-necked Phalarope - Large flocks were regularly seen: about 500 were flying northward in large flocks on 23 July; 1500+ were seen south of Storm Islands along two separate tide lines strung out into the distance to the west; and 1000 were north of Storm Islands on 31 July. All appeared to be in winter plumage.

California Gull - 20 adults and 20 immatures were roosting on islet 1 on 25 July. 150 birds, half of them immature, on islet 1 on 31 July.

Herring Gull - 2 adults roosting on islet 1 on 25 July.
Herring / Thayer's Gull - 10 on islet 1 on 31 July.
Belted Kingfisher
Rufous Hummingbird
Chestnut-backed Chickadee
Winter Wren
Golden-crowned Kinglet
Ruby-crowned Kinglet
Swainson's Thrush
Hermit Thrush - 1 nest with 2 chicks in 3 m spruce seedling on islet 23 on 23 July.
Varied Thrush
Orange-crowned Warbler
Fox Sparrow
Song Sparrow
Red Crossbill
Pine Siskin

Harbour Seal - Seen regularly; maximum of 20 on 22 July.
River Otter - Runs and scats of fish.
Northern Sea Lion - 1 bull on 31 July.
Killer Whale - 1 male, 1 female and 1 younger whale were seen on 24 July and on 27 July.

QS-040 NAIAD ISLETS 92 M/4

Location: North-east of the Storm Islands. 51°01'32"N 127°41'18"W

Land status: Provincial Ecological Reserve.

Date of visit: 2 August 1987 (0950-1100 h).

Colony access: Drop-off from boat.

Observers: M. Rodway, R. Chaundy.

Census method: Total count.

Description: These islets are mostly bare rock, but the highest islet, rising to 16 m elevation, has a lush growth of grass and forbs over shallow soil.

Nesting species: There was no sign of burrowing in the lush vegetated area. The soil is shallow there but probably deep enough to support storm-petrel burrows.

Black Oystercatcher: We found 1 nest containing 1 egg. The nest was made of mussel and limpet shells plus a few rock chips. There were 7 oystercatchers around the islets, only one pair of which appeared to be nesting.

Glaucous-winged Gull: We counted 54 nests around the islets (Table QS040-1). Nests were made of grass and forbs. Most young were small and downy; many eggs were pipping.

Table QS040-1. Glaucous-winged Gull nests on Naiad Islets in 1987.

Islet	Empty	1E	2E	3E	2E1Y	1E2Y	1E1Y	1Y	2Y	3Y	Total
Main	18	4	4	2	1		2	3	2		36
E rocks	2	2	1	1		1	4		4	3	18
Total	20	6	5	3	1	1	6	3	6	3	54

Pigeon Guillemot: Thirteen guillemots were on the rocks and water around the main islet. Breeding was not confirmed.

Associated species:

Pelagic Cormorant - 1 in nonbreeding plumage.
Common Murre - 1

Other birds and mammals sighted

Harlequin Duck - 21 in eclipse plumage.
Wandering Tattler - 1
Black Turnstone - 3
Red-necked Phalarope - 228 feeding and flying about.
California Gull - 1500 roosting; about 30% immatures and 70% adults.
Herring/Thayer's Gull - 40
Song Sparrow

QS-050 REID ISLETS 92 M/4

Location: Off the east end of the Storm Islands.
51°01'08"N 127°41'25"W

Land status: Provincial Ecological Reserve.

Date of visit: 2 August 1987 (1000-1330 h).

Colony access: Drop-off from boat.

Observers: M. Lemon, M. Rodway, B. Carter, R. Chaundy.

Census method: Line transects: 7 quadrats, 2x2 m, surveyed at 15 m intervals along two parallel transects spaced 22 m apart and run at bearings of 134 and 314°. Transects 1 and 2 were 61 and 59 m long and had average slopes of 27° (range: 15-35°) and 18° (range: 5-30°) respectively. Storm-petrel occupancy was determined in two randomly chosen plots, plot 3 (6 burrows) on transect 1 and plot 2 on transect 2 (5 burrows). Total count for gulls.

Description: Reid Islets have a total area of 1.66 ha, 0.33 ha of which are vegetated, and rise to a maximum elevation of 27 m. Dense salmonberry mixed with elderberry covers most of the main islet, with a stand of spruce trees on top and a grassy fringe above the shore rock. Other islets are mostly bare with grassy patches.

Nesting species:

Leach's Storm-Petrel: Storm-petrels were burrowing throughout vegetated areas under forbs, shrubs and in open ground (Tables QS050-1,2; Fig. QS050-1). Of eleven burrows whose contents were determined in occupancy plots, 7 contained incubating Leach's Storm-Petrels, 2 held Leach's Storm-Petrel adults with small chicks, 1 had a cold egg, and 1 was empty. Of 3 other burrows whose contents were incidentally determined, 1 held an incubating Leach's Storm-Petrel, and 2 held single warm eggs. We found no evidence of nesting by Fork-tailed Storm-Petrels, though one pair of Fork-tailed Storm-Petrel wings was found. The average length of burrows was 45.5 ± 5.8 cm (n = 11).

1987 Population estimate:

Number of sample plots:	7 (28 m^2 - 0.9% of colony)
Average density:	38,600 ± 6500 burrows/ha
Colony area:	0.33 ha
Total burrows:	12,641 ± 2129
1987 Occupancy rate:	91% (10 of 11 known)
Ratio of FTSP:LSPE:	0:10
1987 Nesting population:	
Leach's Storm-Petrel:	11,503 ± 1937 pairs

Table QS050-1. Number of storm-petrel and Cassin's Auklet burrows in 2x2 m plots along transects on Reid Islets in 1987.

	Transect			
	Storm-petrel		Cassin's Auklet	
Plot	1	2	1	2
1	3	17	0	1
2	21	11	0	0
3	14	19	2	0
4	23		0	

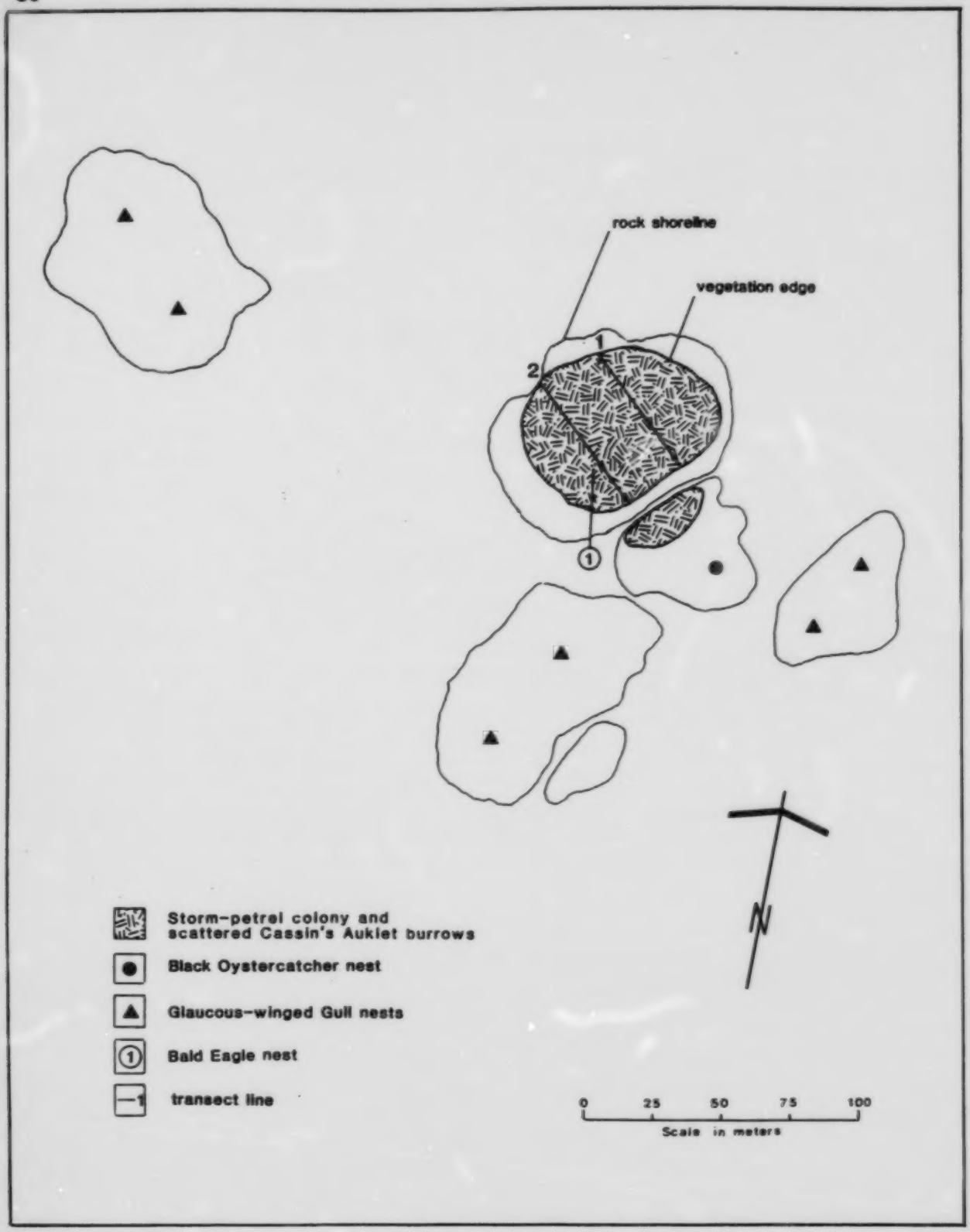

Figure QS050-1. Seabird colony areas and transect locations on Reid Islets in 1987.

Table QS050-2. Habitat locations of storm-petrel burrow entrances along transects on Reid Islets in 1987.

Habitat locations	Number of burrows	Percent of total
Forbs	43	44
Shrubs	29	30
Open ground	13	13
Mossy deadfall	6	6
Into bank	5	5
Tree base	1	1

Black Oystercatcher: We found 1 empty scrape made of dried stalks plus a few pebbles and mussel shells. One pair of adults were very agitated by our presence. Two other oystercatchers were seen.

Glaucous-winged Gull: We counted 36 nests on rocky areas (Table QS050-3). Nests were made of grass. Most young were small; one group of 3 young were large and three-quarters feathered. We suspected young around 4 of the empty nests.

Table QS050-3. Glaucous-winged Gull nests on Reid Islets in 1987.

Islet	Empty	1E	2E	3E	2E1Y	1E2Y	1E1Y	1Y	2Y	3Y	Total
E rock	6							1		1	8
S rock	8	1						4			13
W rock	3		1	1				3	2	5	15
Total	17	1	1	1				8	2	6	36

Pigeon Guillemot: There were 13 guillemots on the south rock. Breeding was not confirmed.

Cassin's Auklet: Cassin's Auklet burrows were sparsely distributed throughout vegetated areas (Table QS050-1; Fig. QS050-1). Two of

the burrows in surveyed quadrats were under salmonberry, and one was in open ground. The contents of two burrows were determined: one petrel-sized burrow held a large, feathering chick, and one, typical-sized burrow contained an addled egg. Both burrows were 50 cm long.

1987 Population estimate:

Number of sample plots:	7 (28 m^2 - 0.9% of colony)
Average density:	1071 $\pm$ 743 burrows/ha
Colony area:	0.33 ha
Total burrows:	350 $\pm$ 243
1987 Occupancy rate:	not determined

Use median British Columbia rate of 75% (Rodway *et al.* 1988).

1987 Nesting population:	263 $\pm$ 182 pairs

Predation: We found 1 pair of Fork-tailed Storm-Petrel wings, 1 Leach's Storm-Petrel wing, 1 adult Glaucous-winged Gull carcass, and 1 Rhinoceros Auklet carcass.

Associated species:

Pelagic Cormorant - 1 immature.

Bald Eagle - 2 adults and 2 immatures; 1 nest 6 m high in a 10 m spruce on the southwest corner of the main islet. One fledgling was seen in the nest.

Peregrine Falcon - 1 flying over.

Tufted Puffin - 1 flying.

Other birds and mammals sighted

Wandering Tattler - 1
Black Turnstone - 14
Winter Wren

QS-060 EMILY GROUP 92 M/4

Location: West of Allison Harbour. 51°01'40"N 127°34'W

Land status: Crown land.

Date of visit: 7 July 1982 (1640-1700 h).

Colony access: Drop-off from boat.

Observers: M.S. Rodway, A. Bell, C.M. Rodway.

Census method: Total count.

Description: These wooded islets have a salal understory with grassy and rocky perimeters. They have a maximum elevation of 53 m.

Nesting species:

Black Oystercatcher: There was 1 nest containing 1 egg on the small, east islet. The nest was a worn dirt bowl lined with shells in a small tuft of grass growing in a crack in the rock. Two adults were present.

Pigeon Guillemot: One bird flew out of a burrow on the vegetation edge at the top of a rock bluff on southwest side of the large northwest island. One other adult was on the water nearby.

Associated species:

Glaucous-winged Gull - 2 adults flew away.

Other birds and mammals sighted

Harbour Seal - 4

QS-070 ROGERS ISLANDS 92 M/4

Location: Scuth-west of Allison Harbour. 51°01'06"N 127°34'54"W

Land status: Crown land.

Date of visit: 7 July 1982 (1707-1800 h).

Colony access: Drop-off from boat.

Observers: M.S. Rodway, A. Bell, C.M. Rodway.

Census method: Total count.

Description: These two rocks, rise to 16 m elevation, and have patches of grass on top.

Nesting species:

Black Oystercatcher: We found 2 nests, one on each rock: 1 with 2 eggs and 1 with 3 eggs. Nests were dirt bowls. One dead oystercatcher was found on the west island.

Glaucous-winged Gull: We counted 138 nests on the two rocks (Table QS070-1). Nests were made of grass and young were hatching. There were 250 gulls, including 30 immatures roosting.

Table QS070-1. Glaucous-winged Gull nests on Rogers Islands in 1982.

Islet	Empty	1E	2E	3E	4E	2E1Y	1E2Y	1E1Y	1Y	2Y	3Y	Total
W rock	17	10	16	23		1	4	2	6	3	1	83
E rock	3	2	4	24	1	4	8	1	2	3	3	55
Total	20	12	20	47	1	5	12	3	8	6	4	138

Pigeon Guillemot: Two birds were present but no nests were found.

Associated species:

Fork-tailed Storm-Petrel - 2 flying.

Other birds and mammals sighted:

Whimbrel - 5
Black Turnstone - 6
Least Sandpiper - 14
Short-billed Dowitcher - 4
Red-necked Phalarope - 2
California Gull - 5 immatures.
Herring Gull - 1

QS-080 HARRIS ISLAND 92 M/4

Location: West of the Southgate Group. 51°00'02"N 127°33'52"W

Land status: Crown land.

Date of visit: 7 July 1982 (1810-1830 h).

Colony access: Drop-off from boat.

Observers: M.S. Rodway, A. Bell, C.M. Rodway.

Census method: Total count.

Description: Harris is a 12 m high grassy rock with a navigation light on the top.

Nesting species:

Black Oystercatcher: Two pairs were present. We found one empty scrape and two newly hatched, separate chicks. We were uncertain if the chicks belonged to the same or different nests, but concluded that both pairs were nesting.

Glaucous-winged Gull: There were 28 nests on Harris Island (Table QS080-1). Nests were made of grass. Many young were just hatching. One dead chick was found.

Table QS080-1. Glaucous-winged Gull nests on Harris Island in 1982.

Empty	1E	2E	3E	2E1Y	1E2Y	1E1Y	1Y	2Y	3Y	Total
2	1	4	12	1	2		3	1	2	28

Pigeon Guillemot: Two birds were present but no nests were found.

Associated species:

Pelagic Cormorant - 140 immatures.
Brandt's Cormorant - 13 immatures.

Other birds and mammals sighted

Whimbrel - 2
Least Sandpiper - 6

QS-090 ANNIE ROCKS 92 L/14

Location: North-west of Shelter Bay. 50°58'44"N 127°29'50"W

Land status: Crown land.

Date of visit: 7 July 1982 (1830-1850 h).

Colony access: Drop-off from boat.

Observers: M.S. Rodway, A. Bell, C.M. Rodway.

Census method: Total count.

Description: Annie is a 7 m high rock, mostly bare with patches of grass.

Nesting species:

Black Oystercatcher: We found one nest with 1 egg in a worn dirt bowl. Two adults were present.

Glaucous-winged Gull: We found 7 empty nests made of grass. There was no sign of eggs. Ten adults were present.

Other birds and mammals sighted

Black Turnstone - 1
Short-billed Dowitcher - 2

QS-100 TREE ISLETS 92 L/13

Location: North-east of Pine Island. 50°59'N 127°42'40"W

Land status: Provincial Ecological Reserve.

Date of visit: 17 (exploration), 18 (transects and gull count) and 19 (transects and occupancy) July 1986.

Colony access: Drop-off from boat.

Observers: M. Lemon, B. Carter, D. Garnier, P. Haist.

Census method: Line transects: 17 quadrats, 2x2 m, surveyed at 15 m intervals along three parallel transects. Transects 1, 2 and 3 were run at 26, 206 and 206°, and were 77, 88 and 66 m long respectively. Slope and elevation were not measured along transects. Area was calculated from a planar representation made from measurements taken in the field. Storm-petrel occupancy was determined along transects and in four plots located on the southeast end of the main islet (Table QS100-3; Fig. QS100-1). Total count for gulls.

Description: Tree Islets have a total area of 6.9 ha, 2.5 ha of which are vegetated, and a maximum elevation of 40 m. Smaller islets are mostly bare with higher grassy patches, but the main islet has a spruce forest with a predominantly shrub understory, including salmonberry, elderberry and currant. Open areas of Maianthemum, fern and grass occur on the perimeter and in some interior areas.

Nesting species:

Storm-petrel: Storm-petrels were burrowing throughout vegetated areas in open ground, into banks, and under forbs, ferns and shrubs (Tables QS100-1,2; Fig. QS100-1). Fork-tailed Storm-Petrel burrows held chicks or adults and Leach's Storm-Petrels were incubating

eggs at the time of our survey (Table QS100-3). We heard both species calling from burrows. The average length of burrows was 41.2 ± 3.7 cm (n = 30).

1986 Population estimate:

Number of sample plots:	17 (68 m² - 0.3% of colony)
Average density:	24,600 ± 2500 burrows/ha
Colony area:	2.5 ha
Total burrows:	61,466 ± 6247
1986 Occupancy rate:	89.7 ± 5.2% (35 of 39 known)
Ratio of FTSP:LSPE:	5:28 (15%:85%)
1986 Nesting population:	
Fork-tailed Storm-Petrel:	8,298 ± 969 pairs
Leach's Storm-Petrel:	47,021 ± 5489 pairs

Table QS100-1. Number of storm-petrel and Cassin's Auklet burrows in 2x2 m plots along transects on Tree Islets in 1986.

	Transect					
	Storm-petrel			Cassin's Auklet		
Plot	1	2	3	1	2	3
1	6	15	2	1	0	0
2	8	13	8	-	-	-
3	20	14	7	-	-	-
4	8	12	9	-	-	-
5	7	9	8	-	-	-
6	10	11		0	-	

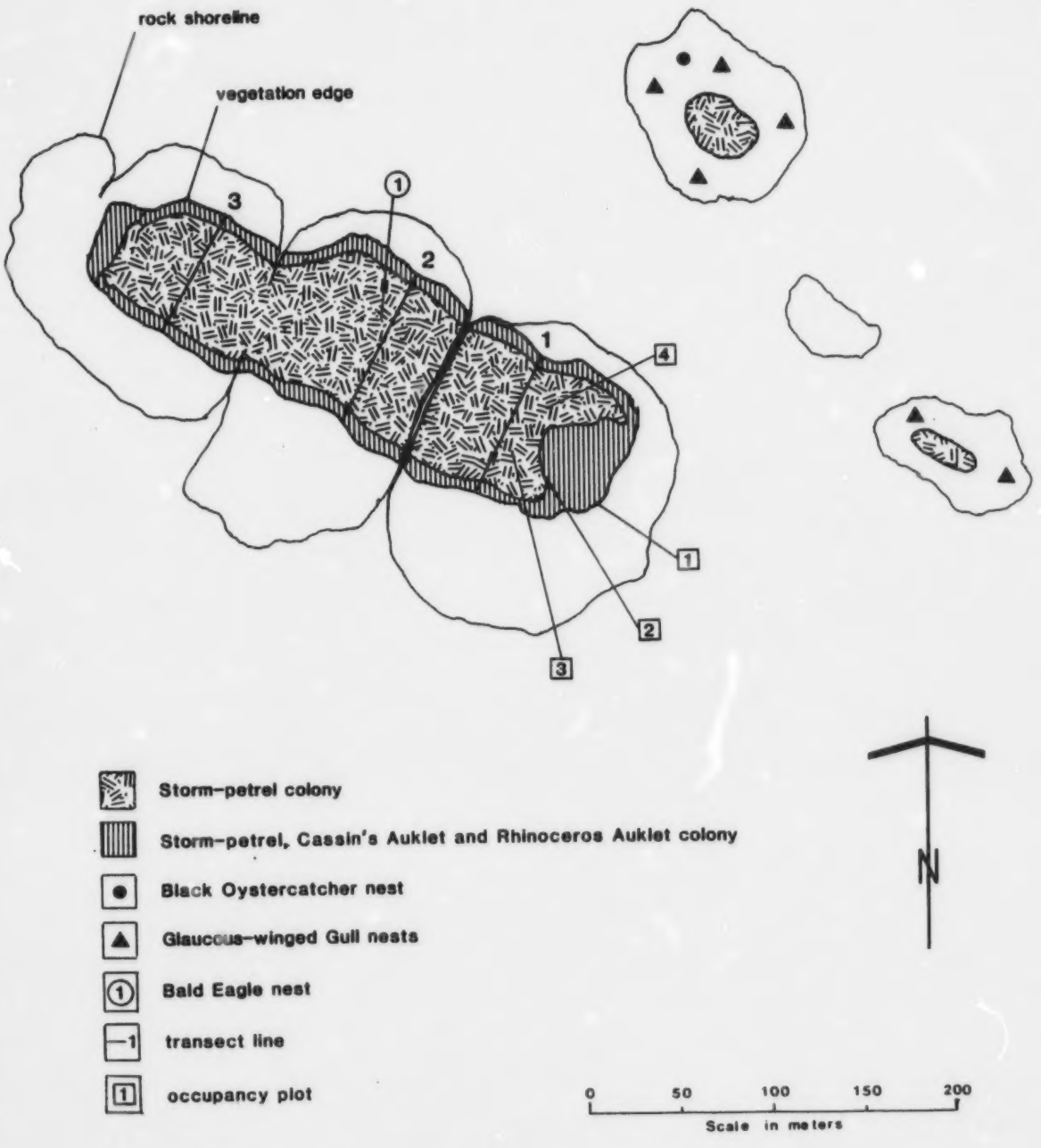

Figure QS100-1. Seabird colony areas and transect locations on Tree Islets in 1986.

Table QS100-2. Habitat locations of storm-petrel burrow entrances along transects on Tree Islets in 1986.

Habitat locations	Number of burrows	Percent of total
Open ground	37	22
Forbs	29	17
Into bank	27	16
Fern	25	15
Shrubs	16	10
Mossy deadfall	10	6
Dead tree roots	8	5
Tree base	6	4
Stump	6	4
Live tree roots	3	2

Table QS100-3. Occupancy of storm-petrel burrows on Tree Islets in 1986.

Location					Fork-tailed		Leach's			
Tran	Plot	Empty	Cold egg	Warm egg	Adult	Chick	Adult	Adult + egg	Total occup	Total known
1	1		1					1	2	2
1	2							1	1	1
1	3						2	1	3	3
1	5	1						1	2	2
1	6	1						1	1	2
2	1						1		1	1
2	2	1						2	2	3
2	3			1					1	1
2	4					1		1	2	2
3	5				1				1	1
Occupancy plots:										
	1	1					1	5	6	7
	2							4	4	4
	3					1	1	5	7	7
	4				1	1		1	3	3
Total		4	1	1	2	3	5	23	35	39

Black Oystercatcher: There was 1 nest with 2 eggs on the northeast islet. Six adults were seen, but only 1 nest was found.

Glaucous-winged Gull: We counted 59 nests on rocky areas of the northeast and most eastern islets (Table QS100-4; Fig. QS100-1). Nests were made of grass. There were no young and many nests were empty. Three depredated eggs were found.

Table QS100-4. Glaucous-winged Gull nests on Tree Islets in 1986.

Islet	Start	Empty	1E	2E	3E	2E1Y	Total
Northeast	5	5		3	6	1	20
East	10	20	3	4	2		39
Total	15	25	3	7	8	1	59

Pigeon Guillemot: Thirty-eight birds were counted on the southeast end of the main islet at 1100 h on 19 July. Three nests were found: 1 with 1 egg and 1 small chick in a deep crevice; 1 with 2 eggs under a large boulder; and 1 with 2 small chicks in a crevice.

Cassin's Auklet: Cassin's Auklet burrows were sparsely distributed around the perimeter of the main islet within 7 m of the edge of the vegetation (Table QS100-1; Fig. QS100-1). The contents of 3 burrows were determined: 2, 70 and 100 cm long, held large, feathering chicks, and one, 70 cm long, contained a cold egg. Sampling within surveyed quadrats was poor resulting in a large standard error for the burrow density estimate (625 $\pm$ 625 burrows/ha). From exploration, we estimated about 350 burrows, and using the median British Columbia occupancy rate of 75% (Rodway *et al.* 1988), we estimated a nesting population of 250 pairs.

Rhinoceros Auklet: Rhinoceros Auklets were nesting on the perimeter of the main islet in similar areas as Cassin's Auklets. Their burrows were less abundant than Cassin's Auklet burrows. One burrow examined on the northeast side of the island contained a small chick and another held a warm egg. We estimated 150 burrows around the islet, and a nesting population of 100 pairs.

Predation: No remains were found in surveyed quadrats, and only 1 Fork-tailed Storm-Petrel feather pile, and 1 Leach's Storm-Petrel pair of wings were found during explorations.

Associated species:

Bald Eagle - 1 immature; 1 nest 18 m high in a 30 m spruce 40 m from shore on the mid-north side of the main islet.

Northwestern Crow - 1

Other birds and mammals sighted

Harlequin Duck - 8 in female plumage.
Rufous Hummingbird
Chestnut-backed Chickadee
Winter Wren
Fox Sparrow
Harbour Seal - 1
Northern Sea Lion - 1 swimming by.

QS-110 PINE ISLAND 92 L/13

Location: Marking the western entrance to Queen Charlotte Strait. 50°58'38"N 127°43'30"W

Land status: Provincial Ecological Reserve, except the area within a 300 m radius of the light tower.

Date of visit: 10-14 July 1984 (transects 16 and 17 and permanent monitoring plots - see Appendix II); 10-13 July (occupancy) and 17-21 July (transects 1-15) 1985; 7-9 July 1986 (occupancy). Surveys were done on Pine Island in conjunction with a Rhinoceros Auklet growth study conducted between 1984 to 1986 (Bertram and Kaiser 1988).

Colony access: There is no easy boat landing on Pine Island. The light station has a crane for lifting small boats out of the water.

Observers: 1984: M. Biro, G. Dawe, D. Powell, D. Swanston; 1985: M. Lemon, B. Carter, D. Garnier, D. Power; 1986: M. Lemon, B. Carter, D. Garnier, P. Haist.

Census method: Line transects: 87 quadrats, 5x5 m, surveyed at 20 m intervals along 17 transects spaced 150 m apart (Table QS110-1). Occupancy was determined in 3 separate plots (Fig. QS110-1).

Description: Pine Island is a circular island, with a steep rocky shoreline cut by gorges and crevices. It is 85 m high and has a total area of 56 ha. Much of the interior is dense salal under a forest of spruce, hemlock and redcedar. Pockets of more open elderberry and huckleberry shrubs occur towards shore, and extensive perimeter areas are covered with moss, grass and forbs. Nesting auklets erode surface vegetation in many of those areas. There is a manned lightstation on the south-west corner.

Table QS110-1. Transect parameters on Pine Island in 1985.

Transect	Bearing (°)	Total length (m)	Elevation (m) Beg.	End	Max.	Average slope (°)	Range of slope (°)
1	78	60	5	20	20	19	14-24
2	152	85	10	25	25	26	5-45
3	159	155	12	25	25	23	11-36
4	188	140	10	40	40	15	9-24
5	197	105	35	40	40	27	18-45
6	209	115	10	38	38	16	8-28
7	229	80	2	32	32	28	20-45
8	260	80	2	28	28	19	8-26
9	310	20	2	9	9	20	20
10	306	135	5	30	30	17	4-28
11	335	120	15	50	55	20	6-32
12	4	145	15	60	60	15	4-28
13	14	60	20	30	30	22	16-30
14	6	122	5	25	25	13	4-35
15*	-	25					
16	100	155	5	25	45	15	2-50
17	280	117	20	30	40	5	0-10

* no burrows in area; plots not surveyed but line explored to 25 m.

Nesting species:

Storm-petrel: We found 12 storm-petrel burrows near the end of transect 8 (Fig. QS110-1), one of which contained eggshell fragments. We suspected that there were more burrows in that vicinity and estimated a nesting population of 100 pairs. We found 1 Fork-tailed Storm-Petrel feather in the vicinity. Breeding was not confirmed, but both Fork-tailed and Leach's Storm-Petrels were heard flying around Pine Island in 1985. Fork-tailed Storm-Petrels were occasionally heard around the lighthouse beginning at 2245 h.

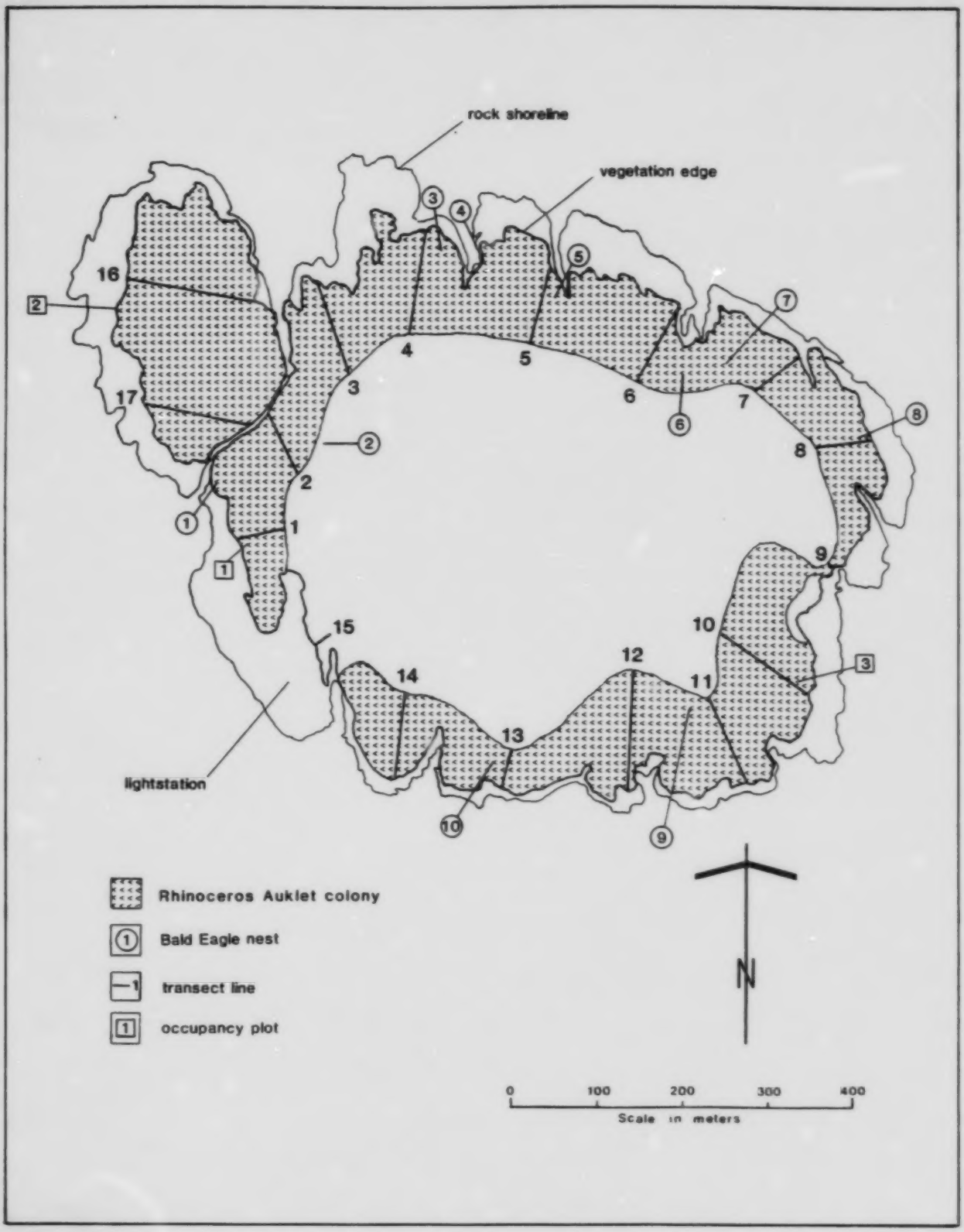

Figure QS110-1. Seabird colony areas and transect locations on Pine Island in 1985.

The area where petrels were nesting faces Tree Islets, and flying birds could originate from there. Only Leach's Storm-Petrels have been confirmed nesting in the past (Campbell 1976).

Pigeon Guillemot: Pigeon Guillemots were suspected nesting in burrows and crevices on the edge of the steep shore rock in the vicinity of transects 11 and 12 and on the edge of the lighthouse gorge near transect 15 (Fig. QS110-1). A maximum of 36 birds were seen along the south side of the island on 20 July 1985. A number of birds were carrying fish. One adult walked into a burrow under a log in the lighthouse gorge at 0620 h on 21 July.

Cassin's Auklet: We found no evidence of nesting by Cassin's Auklets.

Rhinoceros Auklet: Rhinoceros Auklets were nesting around most of the perimeter of Pine Island, extending as far as 135 m from shore (Tables QS110-2,3; Fig. QS110-1). Most burrows occurred under mossy deadfall, dead and live tree roots, grass or stumps (Table QS110-4). Many burrows had multiple entrances; 8% of burrows within surveyed quadrats had multiple entrances: 69 had 2 entrances, 8 had 3 entrances, and 1 had 4 entrances. The average length of burrows was 179.1 $\pm$ 11.9 cm (n = 67). All occupied burrows examined in the three occupancy plots on 10-13 July 1985 contained chicks (n = 22 of 27, 16 of 17, and 20 of 24 known burrows). In 1986, the occupancy rate determined in the same three plots on 7-9 July was 88.7 $\pm$ 1.9% (n = 22 of 24, 15 of 17, and 18 of 21 known burrows). Of the 55 occupied burrows in 1986, there were 50 with chicks, 2 with dead chicks, 1 with an adult and chick, 1 with an incubating adult, and 1 with a cold egg. We used the occupancy rate from 1985 to estimate the nesting population.

1985 Population estimate:

Number of sample plots:	82 (2050 m^2 - 0.9% of colony)
Average density:	4624 $\pm$ 360 burrows/ha
Colony area:	22.7 ha
Total burrows:	104,965 $\pm$ 8172
1985 Occupancy rate:	85.3 $\pm$ 3.4% (58 of 68 known)
1985 Nesting population:	89,535 $\pm$ 7819 pairs

Table QS110-2. Extent of Rhinoceros Auklet colony along transects on Pine Island in 1985.

Transect	Dist. along transect (m)	Distance from nearest shore Min. (m)	Max. (m)	Range of elevation (m)
1	0-56	0	56	5-20
2	0-78	0	78	10-25
3	0-129	0	71	12-25
4	0-125	0	92	10-40
5	0-105	0	78	35-40
6	0-95	0	91	10-30
7	0-76	0	76	2-32
8	0-72	0	72	2-28
9	0-10	0	10	2-6
10	0-135	0	103	5-30
11	0-120	0	107	15-55
12	0-145	0	135	15-60
13	0-50	0	50	20-30
14	0-105	0	85	5-25
15	-			
16	0-155	0	78	5-45
17	0-117	0	71	20-40

Table QS110-3. Number of Rhinoceros Auklet burrows in 5x5 m plots along transects on Pine Island in 1985. Plots considered outside the colony are indicated by a dash.

	Transect																
Plot	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
1	6	16	12	32	20	5	1	5	16	17	15	16	19	19	-	3	11
2	19	21	23	22	13	22	30	15		14	22	6	12	24		31	7
3	1	20	9	21	11	16	17	12		11	12	10	4	14		16	7
4	-	2	13	11	6	8	7	0		9	10	7		23		20	3
5		-	8	8	1	2		-		6	6	10		4		19	26
6			10	0	1					1	8	8		0		26	
7			2	2	-					5		1					
8												0					

Table QS110-4. Habitat locations of Rhinoceros Auklet burrow entrances along transects on Pine Island in 1985.

Habitat locations	Number of burrows	Percent of total
Mossy deadfall	195	26
Dead tree roots	92	12
Live tree roots	90	12
Grass	86	12
Stump	81	11
Into bank	68	9
Open ground	50	7
Forbs	32	4
Tree base	24	3
Shrubs	16	2
Fern	3	0
Rock	3	0

Nocturnal activity: Activity around the colony was recorded on the nights of 20 to 22 July. Birds began flying in at 2115 h, many with fish were flying in between 2250 and 2330 h, and few flew in after 2430 h. Some birds were calling after 2430 h, but the main period of chorusing occurred between 0315 and 0400 h, ceasing by 0500 h. The period when most birds were flying out was between 0415 and 0445 h, just after it started to get light. Flocks were seen flying over the water at 0400 h on 21 July and by 0530 h on 23 July large groups of over 200 birds were flowing southward along the island about 200 m offshore. Some flocks flew clockwise circles before heading out of sight to the south. The morning of 23 July was foggy and activity may have been later than on clear mornings.

Predation: Within plots along transects we found few depredated remains of Rhinoceros Auklets: 6 feather piles, 1 wing, 1 foot, 1 skull, and 1 sternum. Other signs of predation included: 2 eagle pellets with Rhinoceros Auklet feathers and foot, 1 Cassin's Auklet wing and 1 old Fork-tailed Storm-Petrel wing. Outside of surveyed plots we encountered 6 feather piles and 1 wing of Rhinoceros Auklet. Recent remains found within quadrats represented 7 depredated Rhinoceros Auklets, equalling a density of 34.2 $\pm$ 14.2 depredated birds per hectare, and an estimate of 775 $\pm$ 322 depredated Rhinoceros Auklets in the colony at the time of our survey. Many sandlance and few other Rhinoceros Auklet prey species were found along transects.

Associated species: Sightings are from 1985 unless noted.

Pelagic Cormorant - 1 flew out from cliffs near transect 7 on 19 July.

Black Oystercatcher - 6 on west shore on 10 July 1985; 2 on 8 July 1986.

Tufted Puffin - 1 on water off lightstation on 11 July 1986.

Bald Eagle - Maximum of 2 adults and 5 immatures seen. Eagles were seen perched low in the forest in the evening when Rhinoceros Auklets were flying in to their burrows. 10 nests were found, only 2 of which appeared active:

1. 20 m high in 32 m spruce, 5 m from shore. No activity on 10 July.
2. 40 m high in 50 m spruce, 25 m from shore edge of gully. 1 adult and 1 immature flying in vicinity on 17 July.
3. top of 17 m snag, 25 m from shore. No activity on 18 July.
4. 15 m high in 50 m spruce, 15 m from shore. No activity on 18 July.
5. 25 m high in 45 m spruce, 15 m from shore. No activity on 18 July.
6. 30 m high in 40 m tree, 70 m from shore. Dilapidated platform.
7. 18 m high in 23 m snag, 35 m from shore. No activity on 18 July.
8. 22 m high in 30 m spruce, 10 m from edge of knoll. 2 adults present on 19 July.
9. 25 m high in 35 m spruce. No activity on 19 July 1986.
10. 20 m high in 25 m tree, 35 m from shore. No activity on 20 July.

Peregrine Falcon - 1 seen and heard occasionally.

Glaucous-winged Gull - 2 flying by on 21 July.

Northwestern Crow - Maximum of 20 seen. 1 empty nest 2 m high in seedling hemlock.

Common Raven - 1 calling on 23 July.

Other birds and mammals sighted: Sightings are from 1985.

White-winged Scoter - 14 on 16 July
Rufous Hummingbird
Belted Kingfisher
Winter Wren
Swainson's Thrush
Hermit Thrush
Varied Thrush
Fox Sparrow

Song Sparrow

Dall's Porpoise - 2 on 20 July.
Killer Whale - 2 males and 2 females on 21 July 1985; 1 male, 4 females or young males, and 1 calf swimming north on 10 July 1986.

QS-120 BUCKLE GROUP 92 L/13

Location: North-east of Nigei Island. 50°56'29"N 127°39'20"W (Bright Island) and 50°56'24"N 127°37'54"W (Herbert Island).

Land status: Provincial Ecological Reserve.

Date of visit: 3 August 1987 (1100-1820 h).

Colony access: Drop-off from boat.

Observers: M. Lemon, M. Rodway, B.Carter, R. Chaundy.

Census method: Line transects: 17 quadrats, 2x2 m, surveyed at 15 m intervals along four transects. Transects 1 and 2 on Bright Island were run 60 m apart at parallel bearings of 315 and 134°, and transects 3 and 4 on Herbert Island were run 40 m apart at bearings of 30 and 210°. Transects 1, 2, 3 and 4 were 88, 47, 59 and 44 m long and had average slopes of 18° (range - 3-40°), 24° (range - 15-30°), 20° (range - 5-35°) and 28° (range - 5-40°) respectively. Elevation was not measured. Total count for surface nesting species.

Description: Bright and Herbert islands have areas of 3.2 and 1.2 ha and maximum elevations of 34 and 29 m respectively. They are covered with grass and salmonberry under an open spruce forest, while smaller islets in this group are mostly bare rock. An automated weather station was established on Herbert Island in 1984.

Nesting species:

Storm-petrel: Storm-petrels were burrowing throughout vegetated areas primarily under grass, but also under shrubs and ferns and into banks (Tables QS120-1,2; Fig. QS120-1). The one Fork-tailed Storm-Petrel burrow examined held a downy chick. Most Leach's Storm-Petrels were incubating eggs at the time of our survey, some chicks had hatched (Table QS120-3). The average length of burrows was 49.6 $\pm$ 3.6 cm (n = 24).

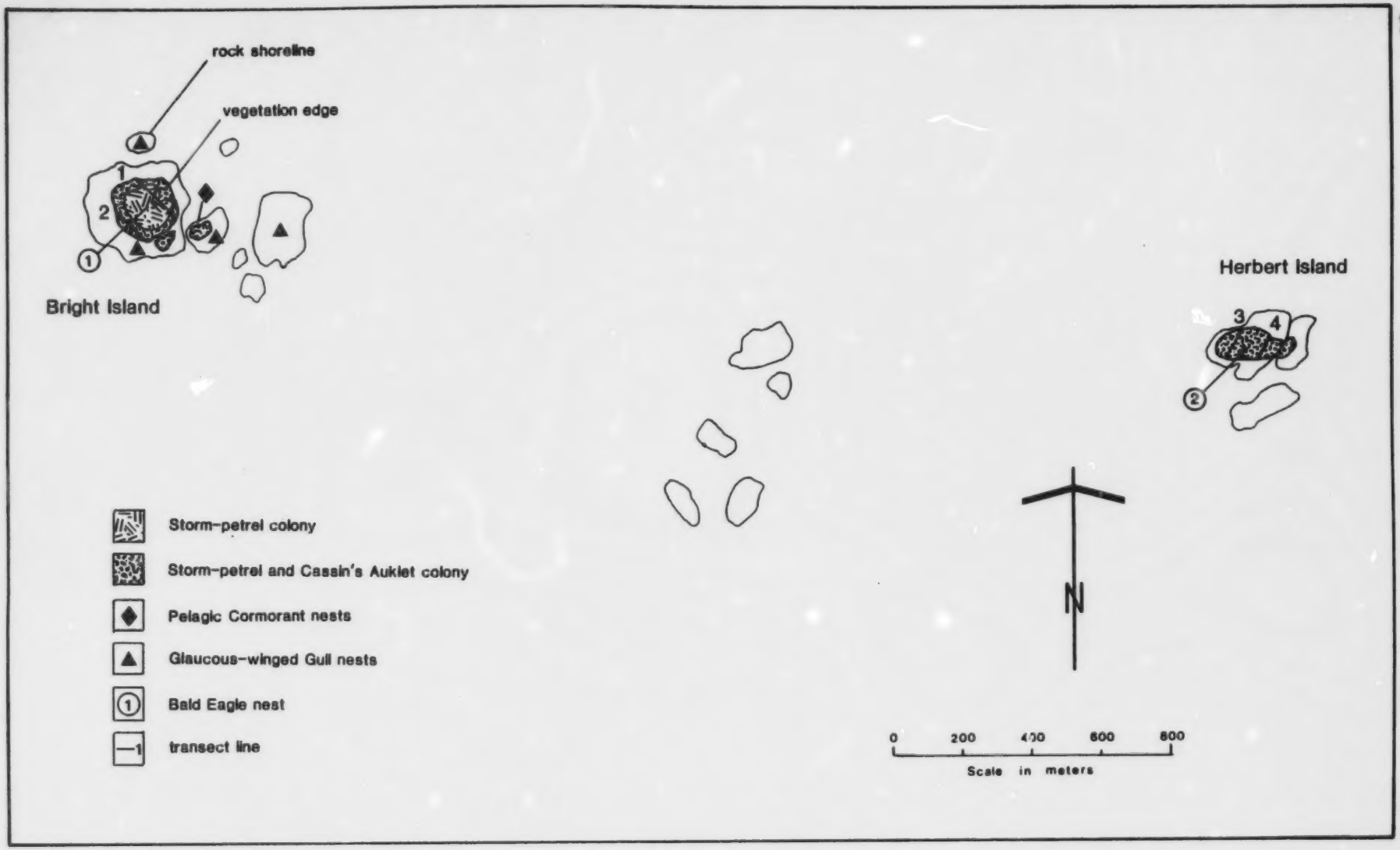

Figure QS120-1. Seabird colony areas and transect locations on the Buckle Group in 1987.

1987 Population estimate:

Bright Island:

Number of sample plots:	10 (40 m^2 - 0.5% of colony)
Average density:	19,900 ± 4100 burrows/ha
Colony area:	0.8 ha
Total burrows:	16,517 ± 3403
1987 Occupancy rate:	94.7 ± 5.6% (18 of 19 known)
Ratio of FTSP:LSPE:	1:17 (6%:94%)
1987 Nesting population:	
Fork-tailed Storm-Petrel:	941 ± 201 pairs
Leach's Storm-Petrel:	14,750 ± 3154 pairs

Herbert Island:

Number of sample plots:	7 (28 m^2 - 0.5% of colony)
Average density:	25,700 ± 4200 burrows/ha
Colony area:	0.5 ha
Total burrows:	13,076 ± 2137
1987 Occupancy rate:	91.7 ± 7.4% (11 of 12 known)
Ratio of FTSP:LSPE:	0:11
1987 Nesting population:	
Fork-tailed Storm-Petrel:	none found
Leach's Storm-Petrel:	12,030 ± 2188 pairs

Total 1987 nesting population on the Buckle Group:

Fork-tailed Storm-Petrel:	941 ± 201 pairs
Leach's Storm-Petrel:	26,780 ± 3839 pairs

Table QS120-1. Number of storm-petrel and Cassin's Auklet burrows in 2x2 m plots along transects on the Buckle Group in 1987. Plots considered outside the colony are indicated by a dash.

	Transect							
	Storm-petrel				Cassin's Auklet			
Plot	1	2	3	4	1	2	3	4
1	6	15	11	18	2	0	4	6
2	2	5	12	5	-	5	0	1
3	4	15	10	11	-	2	1	4
4	13	7[a]	5		3	6[a]	0	
5	1				-			
6	8				7			

[a] plot was only 1.3x2 m

Table QS120-2. Habitat locations of storm-petrel and Cassin's Auklet burrow entrances along transects on the Buckle Group in 1987.

	Storm-petrel		Cassin's Auklet	
Habitat locations	Number of burrows	Percent of total	Number of burrows	Percent of total
Grass	81	57	26	65
Shrubs	19	13	1	3
Into bank	11	8	8	20
Fern	10	7	1	3
Forbs	9	6	1	3
Open ground	9	6	3	8
Live roots	3	2		
Rock	1	1		

Table QS120-3. Occupancy of storm-petrel burrows on the Buckle Group in 1987.

Location Tran	Plot	Empty	Fork-tailed Chick	Leach's Adult	Leach's Adult + egg	Leach's Adult +chick	Leach's Chick	Total occup	Total known
Bright Island:									
1	3				2	1	1	4	4
1	4				2	1	1	4	4
2	1		1	2	2			5	5
2	3			1	2			3	3
2	4	1		1	1			2	3
Herbert Island:									
3	4	1			2	1		3	4
4	2			1[a]	1			2	2
4	2[b]				3			3	3
4	3				1	2		3	3
Total		2	1	5	16	5	2	29	31

[a] pair of adults
[b] outside plot 2

Pelagic Cormorant: Six cormorant nests were located on the edge of the grassy rock just east of Bright Island: 2 empty and 1 each with 2, 3, 4 and 5 eggs. Adults were sitting on nests. Two nonbreeding birds were also present.

Black Oystercatcher: Two adults with 2 fledged young were on Herbert Island. A second, excited pair were on the west rocks of Bright Island. No nests were found but we assumed two pairs were nesting. A group of 21 oystercatchers were roosting on the rock east of Bright Island.

Glaucous-winged Gull: We found 65 nests, only one of which held eggs (3), the rest appeared unused or as if all eggs had been removed. Most nests (59), including the one with eggs, were located on the eastern-most rock adjacent to Bright Island, 4 were found on the grassy rock east of Bright Island, 2 on the rock north of Bright Island, and 2 on the south side of Bright Island (Fig. QS120-1). Nests were made of grass. One old broken eggshell was found.

Pigeon Guillemot: We counted 67 guillemots around Bright Island and 1 around Herbert Island at 1110 h. Breeding was not confirmed.

Cassin's Auklet: Cassin's Auklets were nesting in most vegetated areas on Herbert Island, but were absent from the central section of Bright Island (Table QS120-1; Fig. QS120-1). Burrow entrances were located primarily under grass, but also into banks (Table QS120-2). Lower density burrowing occurred under salmonberry thickets. No occupancy rate was determined because we were too late in the season and many chicks would have already fledged. In 8 burrows examined there were: 2 empty, 1 with a live chick, 3 with dead chicks, and 2 from which chicks had probably fledged. Dead chicks were close to fledging and emaciated. We saw regurgitated food at the entrance to many burrows.

1987 Population estimate:

Bright Island:

Number of sample plots:	7 (28 m^2 - 0.6% of colony)
Average density:	10,000 $\pm$ 2990 burrows/ha
Colony area:	0.5 ha
Total burrows:	4932 $\pm$ 1475

1987 Occupancy rate: Not determined. Use median British Columbia rate of 75% (Rodway *et al.* 1988).

1987 Nesting population: 3699 $\pm$ 1106 pairs

Herbert Island:

Number of sample plots:	7 (28 m^2 - 0.5% of colony)
Average density:	5710 $\pm$ 2230 burrows/ha
Colony area:	0.5 ha
Total burrows:	2905 $\pm$ 1135

1987 Occupancy rate: Not determined. Use median British Columbia rate of 75% (Rodway *et al.* 1988).

1987 Nesting population: 2179 $\pm$ 851 pairs

Total 1987 nesting population on the Buckle Group: 5878 $\pm$ 1396 pairs

Rhinoceros Auklet: We found no evidence of nesting by Rhinoceros Auklets.

Predation: Very little evidence of predation was observed. We found 1 pair of Leach's Storm-Petrel wings and 1 Cassin's Auklet carcass.

Associated species:

Bald Eagle - 2 nests found but neither seemed occupied though there were eagles in the vicinity (Fig. QS120-1):
1. 10 m high in 15 m spruce in centre of Bright Island. 1 adult flying in vicinity but not excited.
2. 18 m high in spruce in centre of Herbert Island. Nest was dilapidated. 2 adults on the island but not around nest.

Northwestern Crow - 4

Other birds and mammals sighted:

Least Sandpiper - 1
Red-necked Phalarope - 800+ feeding and flying around in small flocks.
California Gull - 914
Winter Wren
Fox Sparrow

Northern Sea Lion - 34

QS-130 JOAN ISLAND 92 L/13

Location: North of the Walker Group. 50°55'26"N 127°32'56"W

Land status: Crown land.

Date of visit: 2 July 1982 (1820-1840 h).

Colony access: Drop-off from boat.

Observers: M.S. Rodway, A. Bell, C.M. Rodway.

Census method: Exploration.

Description: Joan Island is a 5 m high rock.

Nesting species: We found no evidence of nesting by seabirds.

Associated species:

Pelagic Cormorant - 1 in breeding and 21 in nonbreeding plumage were roosting.

Black Oystercatcher - 5

Glaucous-winged Gull - 1 adult.

Other birds and mammals sighted:

Harlequin Duck - 1 male and 1 in female plumage.

QS-140 DESERTERS ISLAND 92L/14

Location: In Deserters Group, Ripple Passage. 50°52'30"N 127°28'W

Land status: Crown land.

Date of visit: 1 July 1982 (1615-1700 h).

Colony access: Drop-off from boat.

Observers: M.S. Rodway, A. Bell, C.M. Rodway.

Census method: Total count.

Description: This is a group of densely forested islands with some small rocks off perimeter shores.

Nesting species:

Black Oystercatcher: One pair was suspected nesting on the rock off the large bay on the north side of Deserter's Island, north of the southeast end. Four empty scrapes were found.

Associated species:

Bald Eagle - 1 adult; 1 immature.

Other birds and mammals sighted:

Harlequin Duck - 1 male; 2 female.

QS-150 BARRY ISLET 92 L/14

Location: East of the Deserters Group, at the south-east end of Ripple Passage. 50°53'12"N 127°25'34"W

Land status: Crown land.

Date of visit: 1 July 1982 (1520-1540 h).

Colony access: Drop-off from boat.

Observers: M.S. Rodway, A. Bell, C.M. Rodway.

Census method: Exploration.

Description: Barry Islet is a 9 m high, grassy rock.

Nesting species: No seabirds were present.

Associated species:

Bald Eagle - 6 adult and 13 immature eagles were perched on top of the rock. Prey remains were abundant, and we found a number of eagle "dusting bowls" worn in the grass. No gulls were present.

QS-160 BLEACH ROCK 92 L/13

Location: South-west of the Deserters Group.
50°52'08"N 127°30'20"W

Land status: Crown land.

Date of visit: 2 July 1982 (1000 h).

Colony access: Drop-off from boat.

Observers: M.S. Rodway, A. Bell, C.M. Rodway.

Census method: We boated around the rock.

Description: Bleach is a 5 m high bare rock.

Nesting species: No seabirds were present.

QS-170 CRANE ISLANDS 92 L/13

Location: North of Bell Island in Gordon Channel.
50°50'34"N 127°31'12"W

Land status: Crown land.

Date of visit: 2 July 1982 (1030 h).

Colony access: Drop-off from boat.

Observers: M.S. Rodway, A. Bell, C.M. Rodway.

Census method: We boated around the rocks.

Description: These are small grassy rocks.

Nesting species: No seabirds were present.

QS-180 "DOYLE" ROCKS 92 L/14

Location: Off the south side of Doyle Island.
50°48'28"N 127°28'25"W

Land status: Crown land.

Date of visit: 2 July 1982 (1100 h).

Colony access: Drop-off from boat.

Observers: M.S. Rodway, A. Bell, C.M. Rodway.

Census method: We boated around the rocks.

Description: These are 8 m high rocks.

Nesting species: No seabirds were present.

QS-190 NUMAS ISLANDS 92 L/14

Location: North of Malcolm Point on Malcolm Island.
50°46'N 127°06'W

Land status: Crown land.

Date of visit: 30 June 1982 (1200-1830 h).

Colony access: Drop-off from boat.

Observers: M.S. Rodway, A. Bell, C.M. Rodway.

Census method: Total count.

Description: These wooded islands are covered with dense salal except for narrow, perimeter fringes of grass, moss and bare rock. The islands have a total area of 163 ha, and the largest island rises to 131 m elevation.

Nesting species:

Black Oystercatcher: Five pairs of oystercatchers were nesting (Fig. QS190-1). Three nests each contained single eggs, others were empty. We found 6 empty scrapes in the vicinity of one pair at the west tip of the main island. Most nests were made of shells on rock, one was a worn, grassy bowl lined with limpet and chiton shells.

Glaucous-winged Gull: We counted 65 nests around the islands (Table QS190-1; Fig. QS190-1). Nests were made of grass and young were just beginning to hatch. Most nests were empty and there was evidence of predation: 10 depredated eggshells were found near empty nests.

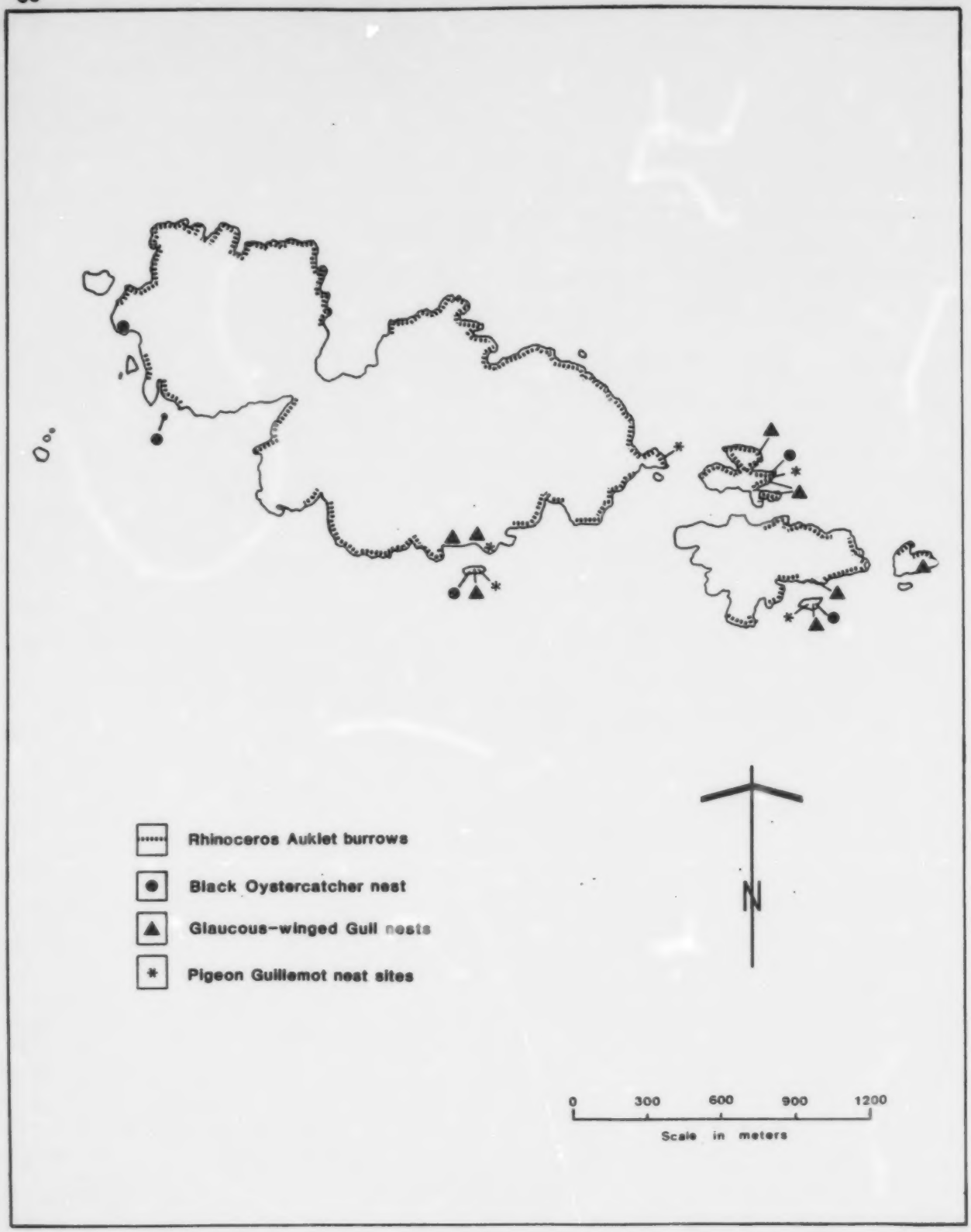

Figure QS190-1. Seabird colony areas on Numas Islands in 1982.

Table QS190-1. Glaucous-winged Gull nests on Numas Islands in 1982.

Location	Empty	1E	2E	3E	2E1?	Total
S side main island	10	2		3	1	16
Islet off S side main island	7	4	2	3		16
NE islet	8			2		10
S side east island	2	3		1		6
Islet off S side east island	10	1	1	3		15
E rock	1	1				2
Total	38	11	3	12	1	65

Pigeon Guillemot: Pigeon Guillemots were nesting in burrows on the edge of the vegetation, in crevices, and under rocks. We found 12 burrows on the east tip of the largest island and about 5 burrows on the east tip of the small northeast island. Guillemots flew out of burrows at those locations and 1 burrow contained an adult incubating 1 egg. We found 2 nests with 2 eggs and 1 nest with 2 small, downy young in rock crevices on the south side of the main island, and 1 nest with 2 eggs under a rock on the rock south of the east island (Fig. QS190-1). A total of 41 adults were counted around those nest sites.

Rhinoceros Auklet: Burrows were distributed around the perimeters of all vegetated islands (Fig. QS190-1). Many were located on the edge of the vegetation at the top of steep shore rock, some were tucked under overhanging salal. On the northern side of the largest island, burrows occurred under tree roots in mossy and grassy fringe areas extending to a maximum of 5 m from the vegetation edge. Burrows appeared active, with well worn entrances and droppings about. One small, downy chick was pulled from one burrow and many hatched eggshells were found in and around burrows. We counted a total of 716 burrows and, using the median British Columbia occupancy rate of 77% (Rodway et al. 1988), estimated a nesting population of 550 pairs.

Associated species:

Pelagic Cormorant - 2 roosting.

Other birds and mammals sighted:

Harlequin Duck - 13 males and 3 unsexed.

Mew Gull - 1 adult.

Harbour Seal - 18

QS-200 STAPLES ISLET 92 L/14

Location: Off the south-west side of the largest Numas Island. 50°46'09"N 127°07'08"W

Land status: Crown land.

Date of visit: 26 June 1982 (1400-1415 h).

Colony access: Drop-off from boat.

Observers: M.S. Rodway, A. Bell, C.M. Rodway.

Census method: Total count.

Description: Staples Islet is a 7 m high bare rock.

Nesting species:

Black Oystercatcher: Two adults were present but no nest was found.

Glaucous-winged Gull: We found 3 empty nests, 1 nest with 1 egg, and 1 nest with 3 eggs. Six adults were present.

Other birds and mammals sighted:

Harbour Seal - 7

QS-210 DEEP SEA BLUFF 92 L/16

Location: West end of Tribune Channel, at the south side of the entrance to Simoom Sound. 50°49'N 126°30'W

Land status: Crown land.

Date of visit: 27 June 1982 (1700 h).

Colony access: Viewed from boat.

Observers: M.S. Rodway, A. Bell, C.M. Rodway.

Census method: Examination from boat.

Description: These are 60 m high cliffs.

Nesting species: There were no birds in the vicinity. Old guano on the cliffs suggested it may have been used as a winter roosting site for cormorants.

QS-220 FOSTER ISLAND 92 L/10

Location: North of the east end of Malcolm Island.
50°42'20"N 126°50'35"W

Land status: Crown land.

Date of visit: 28 June (2000 h) to 29 June (1200 h) 1982.

Colony access: Boat landing in the bay on the east side; drop-off from boat for other areas and offshore rocks. We camped in the east bay.

Observers: M.S. Rodway, A. Bell, C.M. Rodway.

Census method: Total count.

Description: Thick salal covers this 75 m high, wooded island except for small, peripheral areas of grass and bare rock.

Nesting species:

Black Oystercatcher: There were 2 large young associated with each of 2 nests found. Nests were located on the extreme southeast tip of the island and on the small rock off its southwest side. Two adults were present at each site. One chick had a deformed upper mandible that curved to the left so that it did not meet the lower mandible.

Glaucous-winged Gull: We found 3 nests made of grass containing 1, 2 and 3 eggs each. The nest with 3 eggs was located on the southeast tip of the island and the other 2 nests were on the rock off the southwest side. Two adults were present at each location.

Pigeon Guillemot: Guillemots were nesting in burrows at the edge of the vegetation above the shore rock on the south end of the island. One bird flew from a burrow and 22 others were sitting on the water below. We also saw 5 guillemots off the north side of the island, but they were not obviously associated with a nesting site.

Associated species:

Bald Eagle - 2 adults flying.
Common Raven - 1 calling.

Other birds and mammals sighted:

Belted Kingfisher - 1 carrying fish into interior of island.
Rufous Hummingbird
Hermit Thrush
Varied Thrush
Orange-crowned Warbler
Fox Sparrow
Red Crossbill

Harbour Seal - 2 adults with single pups.

QS-230 TWIN ISLETS 92 L/10

Location: South of Foster Island. 50°41'56"N 126°50'40"W

Land status: Crown land.

Date of visit: 29 June 1982 (1210-1500 h).

Colony access: Drop-off from boat.

Observers: M.S. Rodway, A. Bell, C.M. Rodway.

Census method: Total count.

Description: Dense salal under sparse trees covers the higher portions of these two islets, which rise to 29 m elevation. Vegetated areas are surrounded by extensive, bare rocky shores.

Nesting species:

Black Oystercatcher: We found 1 nest made of shells and rock chips and containing 1 egg on the most western treed islet. Four vocal adults were seen on the eastern rocks. There may have been young there but no nests were found.

Glaucous-winged Gull: We found 4 empty nests and 1 nest with 2 eggs on the most eastern rocks. There was one broken eggshell in the vicinity.

Pigeon Guillemot: Guillemots were nesting in burrows at the edge of the vegetation above rock bluffs on the south side of the eastern treed islet. Five birds were present. Breeding was not confirmed.

Other birds and mammals sighted:

Harlequin Duck - 5

QS-240 PENFOLD ISLET 92 L/10

Location: South-east of Foster Island, north of the east end of Malcolm Island. 50°41'22"N 126°48'28"W

Land status: Crown land.

Date of visit: 28 June 1982 (1800-1945 h).

Colony access: Drop-off from boat.

Observers: M.S. Rodway, A. Bell, C.M. Rodway.

Census method: Total count.

Description: Grass and bare rock habitat occur on the perimeter of this wooded, 34 m high islet.

Nesting species:

Black Oystercatcher: One pair was seen around an empty scrape of shells and rock chips on moss located on the main islet.

Glaucous-winged Gull: We counted 53 nests around the main islet and the west rock (Table QS240-1). Nests were made of grass. Young were hatching but many nests were empty as if eggs were still being laid. Depredated eggs and bits of down were found around one empty nest.

Table QS240-1. Glaucous-winged Gull nests on Penfold Islet in 1982.

Islet	Empty	1E	2E	3E	2E1Y	1E2Y	1E1Y	1Y	Total
Main	11	6	3	6			1	1	28
West	9		3	11	1	1			25
Total	20	6	6	17	1	1	1	1	53

Associated species:

Bald Eagle - 2 adults.

Other birds and mammals sighted:

Brant - 3 immatures roosting on west reef.

Sea Otter - 1 female with pup on belly in water at edge of west reef.

QS-250 "COACH" ROCK 92 L/10

Location: Between Coach Islets and Angular Island.
50°42'55"N 126°42'36"W

Land status: Crown land.

Date of visit: 27 June 1982 (1500-1510 h).

Colony access: Drop-off from boat.

Observers: M.S. Rodway, A. Bell, C.M. Rodway.

Census method: Total count.

Description: This is a 2 m high bare rock.

Nesting species:

Black Oystercatcher: We found 1 nest with 2 eggs attended by 2 adults. The nest was made of shells.

Associated species:

Glaucous-winged Gull - 1 adult flew by.

QS-260 GREEN ROCK 92 L/10

Location: South-west of Bonwick Island. 50°40'13"N 126°40'25"W

Land status: Crown land.

Date of visit: 26 June 1982 (1420-1450 h).

Colony access: Drop-off from boat.

Observers: M.S. Rodway, A. Bell, C.M. Rodway.

Census method: Total count.

Description: Green is a 4 m high, grassy rock.

Nesting species:

Black Oystercatcher: We found 1 nest with 3 eggs located on the edge of the grass. The nest was a grass bowl lined with a few shells. Four adults were seen around the rock.

Glaucous-winged Gull: We counted 32 nests: 25 empty, 1 with 1 egg, 4 with 2 eggs, and 2 with 3 eggs. Nests were made of grass. Seventy adults were present.

Pigeon Guillemot: One adult flew out of a crevice on the south side of the island where we found a nest with 2 eggs under a large rock.

Associated species:

Pelagic Cormorant - 4, 2 of which had breeding patches.

Other birds and mammals sighted:

Harlequin Duck - 3

QS-270 "SEABREEZE" ROCK 92 L/10

Location: Off the south end of Seabreeze Island.
50°40'18"N 126°36'28"W

Land status: Crown land.

Date of visit: 26 June 1982 (1500-1510 h).

Colony access: Drop-off from boat.

Observers: M.S. Rodway, A. Bell, C.M. Rodway.

Census method: Total count.

Description: This is a small grassy rock.

Nesting species:

Black Oystercatcher: One empty scrape of shells was attended by 2 adults.

Glaucous-winged Gull: We found 1 nest made of grass that held 3 eggs. Three adults were present.

QS-280 "RIDGE" ROCKS 92 L/10

Location: North and east of Ridge Islets, east of Midsummer Island. 50°39'04"N 126°35'56"W; 50°39'15"N 126°36'23"W; and 50°38'49"N 126°34'30"W

Land status: Crown land.

Date of visit: 26 June 1982 (1330-1410 h).

Colony access: Drop-off from boat.

Observers: M.S. Rodway, A. Bell, C.M. Rodway.

Census method: Total count.

Description: These small grassy rocks are 2 m high.

Nesting species:

Black Oystercatcher: We found 1 nest with 2 eggs and 1 young on the western of the two rocks east of Ridge Islets. The nest was made of shells and rock chips and was attended by 2 adults. There was also an empty scrape on the eastern of those rocks, and an old scrape on the rock north of Ridge Islets, but no birds were present at those sites.

Glaucous-winged Gull: We found 11 nests: single nests with 3 eggs each on the two rocks north of Ridge Islets, 5 nests with 3 eggs each on the western of the two rocks east of Ridge Islets, and 3 empty nests and 1 nest with 3 eggs on the eastern of the two rocks east of Ridge Islets. Nests were made of sticks, lichen, moss and grass. A total of 18 adults were present.

Associated species:

Northwestern Crow - 1 on rocks east of Ridge Islets.

Other birds and mammals sighted:

Harbour Seal - 5 adults with 2 pups.

QS-290 WHITE CLIFF ISLETS 92 L/10

Location: West of Fire Island, north of Swanson Island.
50°39'12"N 126°43'38"W

Land status: Crown land.

Date of visit: 27 June 1982 (1220-1240 h).

Colony access: Drop-off from boat.

Observers: M.S. Rodway, A. Bell, C.M. Rodway.

Census method: Total count.

Description: Extensive rocky perimeters, with some grassy patches, surround small wooded areas on these 15 m high islets.

Nesting species:

Black Oystercatcher: There was 1 nest with 2 small, downy chicks on the east end of the east islet. Chicks were hiding away from the nest and 2 adults were calling in the area.

Associated species:

Glaucous-winged Gull - 4 adults were on the west islet but no nests were found.

QS-300 SURGE ISLANDS 92 L/10

Location: North-east of Wedge Island, north of Swanson Island.
50°38'25"N 126°42'47"W

Land status: Crown land.

Date of visit: 27 June 1982 (1120-1140 h).

Colony access: Drop-off from boat.

Observers: M.S. Rodway, A. Bell, C.M. Rodway.

Census method: Total count.

Description: Larger islands are forested and rise to 21 m elevation. The most southern islet is a grassy rock.

Nesting species:

Glaucous-winged Gull: One nest made of grass and containing 2 eggs was located on the southern, grassy rock. Two adults were present.

Associated species:

Black Oystercatcher - We found 1 empty scrape on the southern, grassy rock, but no adults were around.

QS-310 PLUMPER ISLANDS 92 L/10

Location: West of Hanson Island. 50°35'36"N 126°47'23"W

Land status: Crown land.

Date of visit: 28 June 1982 (1100-1120 h).

Colony access: Viewed from boat.

Observers: M.S. Rodway, A. Bell, C.M. Rodway.

Census method: Total count.

Description: The main forested islands are 108 m high. There are rock bluffs on the south end of the small islands on the northeast side of the group.

Nesting species:

Pigeon Guillemot: Adults were seen flying out of two crevices on the cliffs on the south end of the small islands on the northeast side of the group. We found 1 nest with 2 eggs in one of the crevices. Five other adults were on the rocks and water below the cliffs.

Associated species:

Bald Eagle - 8 adults; 1 immature.
Northwestern Crow - 2

Other birds and mammals sighted:

Harbour Seal - 2

QS-320 STEPHANSON ISLET 92 L/10

Including surrounding rocks and rock to the northwest.

Location: Between Hanson Island and Pearse Islands. 50°34'28"N 126°49'30"W (Stephanson Islet) and 50°50'09"N 126°34'48"W (rock to northwest).

Land status: Crown land.

Date of visit: 28 June 1982 (1120-1310 h).

Colony access: Drop-off from boat.

Observers: M.S. Rodway, A. Bell, C.M. Rodway.

Census method: Total count.

Description: Weathered salal and small spruce trees grow over much of Stephanson Islet, while the perimeter is bare rock and grass. Smaller, surrounding islets are mostly bare rock with some grassy areas. Stephanson Islet is 8 m high.

Nesting species:

Black Oystercatcher: We found 1 nest with 2 eggs on the southwest rock, 1 empty scrape on Stephanson Islet, and 1 nest with 1 large young hiding under a log on the northwest rock. Nests were made of shells and rock chips.

Glaucous-winged Gull: We counted 25 nests on the main islet and the south rocks (Table QS320-1). Nests were made of grass. There was no sign of hatching.

Table QS320-1. Glaucous-winged Gull nests on Stephanson Islet in 1982.

Islet	Empty	1E	2E	3E	Total
Main	3	2	1	4	10
SW rock	7	2	1	1	11
SE rock		1	1	2	4
Total	10	5	3	7	25

Pigeon Guillemot: There were 26 birds on the water between the islets. No nests were found.

Associated species:

Pelagic Cormorant - 1 immature.

Northwestern Crow - 15; 2 empty nests in small spruce trees. One fledgling flying about.

River Otter - Trails and scats.

Other birds and mammals sighted:

Harlequin Duck - 21 males, 3 in female plumage, and 39 unsexed.
Black-legged Kittiwake - 22 immatures roosting.
Black Turnstone - 1
Short-billed Dowitcher - 1
Rufous Hummingbird

QS-330 FULMORE LAKE 92 K/12

Location: Between the head of Port Neville and Call Inlet.
50°35'06"N 125°58'06"W

Land status: Crown land.

Date of visit: 24 June 1982 (1500-1600 h).

Colony access: Drop-off from boat.

Observers: M.S. Rodway, A. Bell, C.M. Rodway.

Census method: Total count.

Description: Nesting occurs on the small, 5 m high, wooded islet towards the west end of Fulmore Lake. Salal covers most of the islet, with moss and some grass on the periphery.

Nesting species:

Glaucous-winged Gull: We found 1 nest with 3 eggs attended by 2 adults, as well as 2 old nests with addled eggs in them, probably from the previous year. The active nest was on the moss under salal near shore on the south side of the islet.

Associated species:

Bald Eagle - 1 adult fishing.

Other birds and mammals sighted:

Common Loon - 1 in breeding plumage.

Common Merganser - 1 male.

Spotted Sandpiper - 1

Red-tailed Hawk - 2 calling.

Mew Gull - 4 nests: 3 in trees or snags; 1 on drift logs on shore. One tree nest was on top of a 2 m high broken snag, 1 was on the trunk of a tree that was growing sideways, and 1 was on a branch, 8 m high in a 15 m high hemlock. Two nests were incomplete and 2 were too high to inspect. Six adults were present; 1 was sitting on the nest in the hemlock tree.

Belted Kingfisher - 1
Tree Swallow - 2

QS-340 "GOAT" ISLAND 92 K/5

Location: Off the mouth of Billygoat Bay on the northeast side of Helmcken Island. 50°24'06"N 125°51'30"W

Land status: Crown land.

Date of visit: 23 June 1982 (1630-1700 h).

Colony access: Drop-off from boat.

Observers: M.S. Rodway, A. Bell, C.M. Rodway.

Census method: Total count.

Description: The interior of this 49 m high island is salal under a hemlock forest, with small grassy patches on the perimeter.

Nesting species:

Glaucous-winged Gull: We found 4 empty nests, 1 nest with 2 eggs and 1 nest with 3 eggs on a small fringe area of grass on the east end of the islet. Nests were built of grass. Ten adults were present.

Pigeon Guillemot: Two birds flew out of crevices on the east end of the islet. Four suspected nest sites were found in crevices, but none contained eggs. Eight adults were present in the vicinity.

Associated species:

Bald Eagle - 1 nest on south end of Helmcken Island, on top of a 25 m high broken tree, 10 m from shore. 1 young visible in nest. 2 adults perched nearby.

Marbled Murrelet - 4 in summer plumage around Helmcken Island.

Northwestern Crow - 4

Other birds and mammals sighted:

Spotted Sandpiper - 1

Harbour Seal - 3
Harbour Porpoise - 2
Dall Porpoise - 2

SUMMARY AND CONCLUSIONS

Over a million seabirds are currently estimated to breed at 28 colonies in the Queen Charlotte Strait and Johnstone Strait region. The cluster of five colonies at the western entrance to Queen Charlotte Strait, including Storm Islands, Reid Islets, Tree Islets, Pine Island, and the Buckle Group, support 99.8% of that population. Rhinoceros Auklets, Fork-tailed Storm-Petrels, and Leach's Storm-Petrels are the most abundant species (Table QS-1).

Comparing numbers of surface nesting species recorded in 1975 (Campbell 1976) to those recorded on recent surveys suggests that Pelagic Cormorant numbers have declined and Black Oystercatcher and Glaucous-winged Gull populations have remained similar. Tufted Puffins have not been recorded breeding on Storm or Pine islands since 1929 (Rodway *et al.* in prep).

We observed no signs of deer or mink, and encountered minimal evidence of predation on nesting seabirds during our surveys of colonies in this region. Burrowed areas on dense storm-petrel colonies on Storm, Reid, and Tree islands and on the Buckle Group are fragile and would be easily damaged by human or large mammal traffic.

The following codes have been used on Table QS-1 to indicate the type of population estimates presented. A more detailed definition of these codes can be found in Rodway *et al.* (in prep).

S: breeding suspected but not directly observed.

x: breeding confirmed but population not estimated.

e: population estimated without systematic sampling or total counts.

t: population estimated from systematic sampling along transects.

26: a number without a code indicates a total count.

E: extinct.

(): number of birds in breeding plumage on or near the colony.

Acronyms for species names follow Campbell and Harcombe (1985; see Appendix I).

Table QS-1. Current summary of breeding seabird populations in Queen Charlotte and Johnstone straits. Estimates are of breeding pairs for all species except Pigeon Guillemots. To include that species, total populations are given as individual birds. Data codes and sources are explained on previous page.

SITE CODE	SITE NAME	FTSP	LSPE	PECO	BLOY	GWGU	PIGU	CAAU	RHAU	TUPU	TOTAL BIRDS	SURVEY YEAR*
QS-010	Bremner It.			16	(6)	144	6x(29)				349	1982
QS-020	McEwan Rock			14		44					116	1982
QS-030	Storm Islands	50800t	191000t	0	18	61	x(111)	300eS	72000t	E	628469	1987
QS-040	Naiad Islets				1	54	S(13)				123	1987
QS-050	Reid Islets		11500t	0	1	36	S(13)	260t			23607	1987
QS-060	Emily Group				1		1(2)				4	1982
QS-070	Rogers Islands				2	138	S(2)				282	1982
QS-080	Harris Island				2	28	S(2)				62	1982
QS-090	Annie Rocks				1	7					16	1982
QS-100	Tree Islets	8300t	47000t	0	1	59	3x(38)	250e	100e		111458	1986
QS-110	Pine Island		100eS				S(36)	0t	89500t	E	179236	1985
QS-120	Buckle Group	900t	27000t	6	2e	65	S(68)	5900t			67814	1987
QS-130	Joan Island				0	0					0	1982
QS-140	Deserters I.				1S	0					2	1982
QS-150	Barry Islet					0					0	1982
QS-160	Bleach Rock				0	0					0	1982
QS-170	Crane Islands					0					0	1982
QS-180	"Doyle" Rocks					0					0	1982
QS-185	Port Hardy						1x				2	1975
QS-190	Numas Islands				5	65	9x(41)		550		1281	1982
QS-200	Staples Islet				(2)	5					10	1982
QS-210	Deep Sea Bluff			0		0	(0)				0	1982
QS-220	Foster Island				2	3	1x(28)				38	1982
QS-230	Twin Islets				1	5	S(5)				17	1982
QS-240	Penfold Islet				1S	53					108	1982
QS-250	"Coach" Rock				1						2	1982
QS-260	Green Rock				1	32	1(1)				68	1982
QS-270	"Seabreeze" Rk.				1S	1					4	1982
QS-280	"Ridge" Rocks				1	11					24	1982
QS-290	White Cliff Its.				1						2	1982
QS-300	Surge Islands					1					2	1982
QS-310	Plumper Is.						1x(7)				7	1982
QS-320	Stephenson It.				3	25	S(26)				82	1982
QS-330	Fulmore Lake					1					2	1982
QS-340	"Goat" Island					6	2x(8)				20	1982
	TOTAL NESTING PAIRS	60000	276600	36	47	844		6710	162150			
	TOTAL BREEDING BIRDS	120000	553200	72	94	1688	433	13420	324300	0	1013207	
	NUMBER OF SITES	3	5	3	20	22	18	4	4	0	29	

METHODOLOGICAL CONSIDERATIONS AND RECOMMENDATIONS

The goal of the inventory program was to establish baseline estimates of breeding seabird populations using replicable survey techniques. Total counts conducted at the appropriate time are readily compared. Partial counts are adequate to detect substantial changes in nesting distribution and population on small colonies. Changes in population estimates for large colonies are more difficult to interpret. The level of precision of estimates derived from systematic sampling along transects depends on the precision of three components which enter into their calculation: colony area, burrow density and burrow occupancy rate. Each component has its own sources of error.

In the methods presented in this report, there is no measure of error for colony area calculations, and its level of precision is unknown. Distance, slope and elevation measurements taken along transects help delineate nesting areas, but precise identification of colony boundaries depends on thorough exploration, careful observations and detailed and explicit note-taking. Sources of error arise whenever observations or field notes are not comprehensive enough to allow unequivocal definitions of colony limits. Training of observers in what evidence to look for, and how to record it unambiguously, is an essential element of an inventory program and directly influences the quality of data obtained. Having an experienced corps of surveyors from year to year maintained a consistent standard for defining colony limits. The accuracy of mapping and measuring colony areas also depends on the quality and scale of available maps.

The standard error of the average burrow density has been calculated for each site. The level of precision and accuracy depends on burrow distribution, sampling intensity and appropriate selection of quadrat size and spacing. Compromises were made between the level of precision desired and the time required to obtain that level. Average densities for small colonies often have large standard errors because they were sampled with few plots. Observer bias in indentifying burrows may create an unmeasured subjective error. Consistent criteria, experienced observers and mutual consultation minimized discrepancies. Studies are required to evaluate the importance of this bias.

Burrow occupancy rates were obtained for large Rhinoceros Auklet and storm-petrel colonies. Digging Rhinoceros Auklet burrows to determine occupancy is a laborious and time-consuming task. Often half or more of the attempts are unsuccessful. It was not feasible to determine the occupancy of burrows within all quadrats, and occupancy was determined at selected locations. Selection of occupancy plots was arbitrary on most colonies. At some colonies, occupancy was determined in a single plot and no standard error could be calculated. We recommend not attempting to

explore burrows in all quadrats unless more time is spent than on the present surveys. Storm-petrel burrows are easier to investigate, though they are often delicate and easily damaged. On most storm-petrel colonies location of occupancy plots was arbitrary. On Storm Islands, storm-petrel occupancy was determined in randomly chosen quadrats and a fixed sample size was obtained at each plot selected. This method facilitates statistical analysis and comparison, and we recommend it for future surveys. Occupancy rates were not determined on small colonies of storm-petrels or Rhinoceros Auklets, nor on Cassin's Auklet colonies which were all small. Research on the variation in occupancy rates within and between colonies, and over time, is required to assess and improve sampling methodology (see Gaston and Jones 1984; Gaston and Collins 1988).

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Appendix I. Index to species names and acronyms.

Birds:

Common Loon	Gavia immer	COLO
Fork-tailed Storm-Petrel	Oceanodroma furcata	FTSP
Leach's Storm-Petrel	O. leucorhoa	LSPE
Brandt's Cormorant	Phalacrocorax penicillatus	BRCO
Pelagic Cormorant	P. pelagicus	PECO
Brant	Branta bernicla	BRAN
Harlequin Duck	Histrionicus histrionicus	HADU
White-winged Scoter	Melanitta fusca	WWSC
Common Merganser	Mergus merganser	COME
Bald Eagle	Haliaeetus leucocephalus	BAEA
Red-tailed Hawk	Buteo jamaicensis	RTHA
Peregrine Falcon	Falco peregrinus	PEFA
Black Oystercatcher	Haematopus bachmani	BLOY
Wandering Tattler	Heteroscelus incanus	WATA
Spotted Sandpiper	Actitis macularia	SPOT
Whimbrel	Numenius phaeopus	WHIM
Black Turnstone	Arenaria melanocephala	BLTU
Western Sandpiper	Calidris mauri	WESA
Least Sandpiper	C. minutilla	LESA
Short-billed Dowitcher	Limnodromus griseus	SBDO
Red-necked Phalarope	Phalaropus lobatus	RNPH
Mew Gull	Larus canus	MEGU
California Gull	L. californicus	CAGU
Herring Gull	L. argentatus	HEGU
Thayer's Gull	L. thayeri	THGU
Glaucous-winged Gull	L. glaucescens	GWGU
Black-legged Kittiwake	Rissa tridactyla	BLKI
Common Murre	Uria aalge	COMU
Pigeon Guillemot	Cepphus columba	PIGU
Marbled Murrelet	Brachyramphus marmoratus	MAMU
Cassin's Auklet	Ptychoramphus aleuticus	CAAU
Rhinoceros Auklet	Cerorhinca monocerata	RHAU
Tufted Puffin	Fratercula cirrhata	TUPU
Rufous Hummingbird	Selasphorus rufus	RUHU
Belted Kingfisher	Ceryle alcyon	BEKI
Tree Swallow	Tachycineta bicolor	TRSW
Northwestern Crow	Corvus caurinus	NWCR
Common Raven	C. corax	CORA
Chestnut-backed Chickadee	Parus rufescens	CBCH
Winter Wren	Troglodytes troglodytes	WIWR
Golden-crowned Kinglet	Regulus satrapa	GCKI
Ruby-crowned Kinglet	R. calendula	RCKI
Swainson's Thrush	Catharus ustulatus	SWTH
Hermit Thrush	C. guttatus	HETH
Varied Thrush	Ixoreus naevius	VATH
Orange-crowned Warbler	Vermivora celata	OCWA
Fox Sparrow	Passerella iliaca	FOSP
Song Sparrow	Melospiza melodia	SOSP

Appendix I (cont'd)

Red Crossbill	Loxia curvirostra	RECR
Pine Siskin	Carduelis pinus	PISI

Mammals:

Northern Sea Lion	Eumetopias jubatus	EUJU
River Otter	Lutra canadensis	LUCA
Sea Otter	Enhydra lutris	ENLU
Harbour Seal	Phoca vitulina	PHVT
Killer Whale	Orcinus orca	ORCA
Harbour Porpoise	Phocoena phocoena	PHPH
Dall's Porpoise	Phocoenoides dalli	PHDA

Appendix II. Permanent seabird monitoring plots established in the Queen Charlotte Strait and Johnstone Strait region.

As part of the Permanent Seabird Monitoring Program for the British Columbia coast, permanent plots for Rhinoceros Auklets were established on Pine Island on 11-14 July 1984. A detailed description of each plot and the number of burrows found within each plot is housed in the Permanent Seabird Monitoring Program file at the Canadian Wildlife Service office in Delta, B.C.

Eight 10x10 m plots were distributed throughout the colony. Locations were mapped on a 1:6400 scale airphoto and distances and bearings were measured to conspicuous landmarks. Plots were marked with engraved aluminum tags nailed to large trees within the plot. Plot corners were marked with flat aluminum stakes, 1.5" wide and 2' tall. The stakes were colour coded with red, blue, green and yellow florescent tape, ordered in a clockwise direction around the plot beginning when facing the interior of the island with red at the lower left corner.